GCSE Mathematics Knowledge Organiser

A1: Algebra Notation

Plot Coordinates
Collect Like terms
Simplify Expressions

A1.1
Plot coordinates in four quadrants

e.g.
Plot the origin (0,0)

Plot the point (2,3)

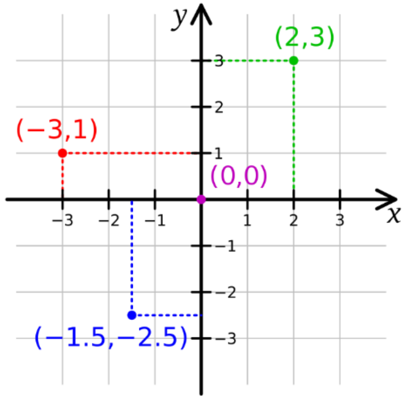
Plot the point (-3,1)

Plot the point
(-1.5, -2.5)

(x coordinate, y coordinate)

For x, move right for positive values and left for negative.
For y, move up for positive values and down for negative.

e.g.



A1.2
Collect like terms by adding and subtracting

e.g.
a + 2a

a + 2b

$5a^2 – 2a^2$

$a^2 – 2a$

Only like terms can be added or subtracted.

e.g.
a + 2a = 3a

a + 2b cannot be added

$5a^2 – 2a^2 = 3a^2$

$a^2 – 2a$ cannot be subtracted

A1.3
Simplify simple expressions by multiplying

e.g.
a x b

2a x 3a

Terms can be simplified when multiplying.
Multiply any numbers first, then write the letters including any powers that result.

e.g.
a x b = ab

$2a \times 3a = 6a^2$

A1: Algebra Notation

Expand a single bracket
Factorise into a single bracket
Substitute into an expression

A1.4 Expand a single bracket e.g. Expand $2(x + 5)$ Expand $x(x - 5)$	Multiply everything in the bracket by what is outside. $2(x + 5) = 2x + 5$ $x(x - 5) = x^2 - 5x$
Expand and simplify expressions with more than one bracket e.g. Expand $3(x + 2) + 2(x – 5)$ $3(x + 2) – 2(x – 5)$	Expand each bracket and then simplify the expression. Take care with negative numbers. $3(x + 2) + 2(x – 5)$ $= 3x + 6 + 2x – 10$ $= 5x - 4$ $3(x + 2) - 2(x – 5)$ $= 3x + 6 -2x + 10$ $= x + 16$

A1.5 Factorise into a single bracket. e.g. $4y - 12$ $y^2 + 7y$	Divide by the highest common factor of each part of each term. e.g. 4 is the HCF of 4 and 12. y is not common to both terms. $4y – 12 = 4(y – 3)$ Y is common to both terns. $y^2 + 7y = y(y + 7)$
A1.6 Substitute into an expression. e.g. Find the value of $3a - b$ when $a = 6$ and $b = -2$.	Replace the letters with the given numbers, then carry out the calculation. Remember BIDMAS and the rules for negative numbers. e.g. $3a – b$ $= 3 \times 6 –(-2)$ $= 18 + 2$ $= 20$

A1: Algebra Notation

Use a formula by substituting numbers

Expand two brackets

A1.7 Use a formula by substituting numbers e.g. Use the formula v = u + at to work out v when u = 5, a = 10, t = 6. Use the formula v = u + at to work out a when v = 32, u = 7, t = 5. Use the formula v = u + at to work out t when v = 5, u = 17, a = -4.	Replace the letters with the given numbers, then carry out the calculation. Remember BIDMAS and the rules for negative numbers. e.g. v = u + at v = 5 + 10 x 6 v = 5 + 60 v = 65 v = u + at 32 = 7 + 5a 25 = 5a a = 5 v = u + at 5 = 17 – 4t -12 = -4t t = 3

A1.8
Expand two brackets.

Use a grid to expand two brackets.
Take care with negative numbers.
Add together the four terms in the grid.
Simplify the two x terms.

e.g.
(x + 3)(x – 2)

	x	+3
x	x^2	+3x
-2	-2x	-6

x^2 + 3x -2x -6
= x^2 + x -6

(2x – 1)(x + 4)

	2x	-3
x	$2x^2$	-3x
+4	+8x	-12

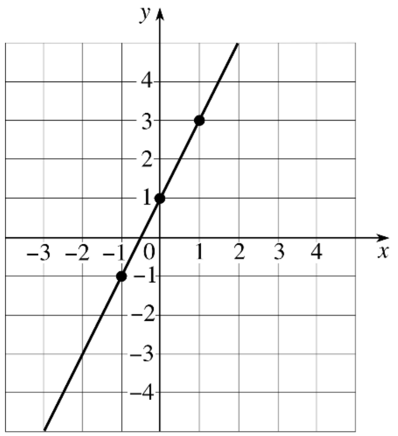
$2x^2$ - 3x +8x -12
= $2x^2$ +5x -12

A1: Algebra Notation

Plot a linear graph from a sequence or formula
Use the index rules for multiplication and division
Use the index laws for raising to a power

A1.9 Plot a linear graph from a sequence or formula e.g. Plot the graph of $y = 2x + 1$	Draw a table of values by substituting values of x into the formula. Plot the points in pencil. Join the points with a ruler and pencil. They should be in a straight line. e.g. (see table and graph below)

x	-1	0	1
y	-1	1	3



A1.10 Use the index rules for multiplication and division e.g. $3a^2 \times 2a^3$ $10a^6 \div 5a^2$	Deal with the numbers first. When multiplying add the indices. When dividing subtract the indices. e.g. $3 \times 2 = 6$ $a^2 \times a^3 = a^{2+3} = a^5$ $3a^2 \times 2a^3 = 6a^5$ $10 \div 5 = 2$ $a^6 \div a^2 = a^{6-2} = a^4$ $10a^6 \div 5a^2 = 2a^4$
A1.11 Use the index rules for raising to a power e.g. $(a^2)^4$ $(2a^6)^3$	Raise any numbers to the power outside the brackets first. Multiply the indices when raising a power to a power. e.g. $(a^2)^4 = a^{2\times4} = a^8$ $2^3 = 8$ $(a^6)^3 = a^{6\times3} = a^{18}$ $(2a^6)^3 = 8a^{18}$

A2: Formulae, Functions and Expressions

Use a formula by substituting numbers

Change the subject of a simple formula

Expand two brackets

A2.1 Use a formula by substituting numbers e.g. Use the formula v = u + at to work out v when u = 5, a = 10, t = 6. Use the formula v = u + at to work out a when v = 32, u = 7, t = 5. Use the formula v = u + at to work out t when v = 5, u = 17, a = -4.	Replace the letters with the given numbers, then carry out the calculation. Remember BIDMAS and the rules for negative numbers. e.g. v = u + at v = 5 + 10 x 6 v = 5 + 60 v = 65 v = u + at 32 = 7 + 5a 25 = 5a a = 5 v = u + at 5 = 17 – 4t -12 = -4t t = 3

A2.2 Change the subject of a simple formula e.g. Make t the subject of the formula $v = u + at$	Use the same balancing steps as when you solve equations to change the subject of the formula. e.g $v = u + at$ (Minus u from both sides of the equation) $v - u = at$ (divide both sides of the equation by a) $\frac{v-u}{a} = t$
A2.3 Expand two brackets. e.g. (x + 3)(x – 2)	Use a grid to expand two brackets. Take care with negative numbers. Add together the four terms in the grid. Simp e.g (grid below) $x^2 + 3x - 2x - 6$ $= x^2 + x - 6$

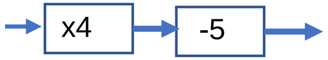
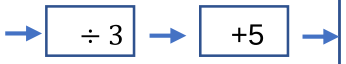
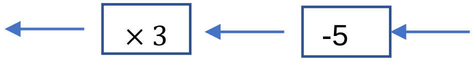
	x	+3
x	x^2	+3x
-2	-2x	-6

A2: Formulae, Functions and Expressions

Substitute into an expression

Use a function machine to find input and output

A2.4 Substitute into an expression.	Replace the letters with the given numbers, then carry out the calculation. Remember BIDMAS and the rules for negative numbers.
e.g. Find the value of 3a - b when a = 6 and b = -2.	e.g. 3a – b = 3 x 6 –(-2) = 18 + 2 = 20
e.g Find the value of abc+ 3b when a= 5, b=3 and c=7	e.g abc+ 3b = 5x3x7-3x3 = 105-9 =96

A2.5 Use a function machine to find input or output	To find the output follow the instructions from left to right. To find the input, reverse the function machine by using inverse functions and follow it from right to left
e.g find the output for the function machine below when the input is 4  	e.g Input is 4 = 4x4-5 Output =11
e.g find the input for the function machine below when the output is 7  	e.g Reverse function machine is  Output is 7 =7-5x3 Input is 6

A2: Formulae, Functions and Expressions

Evaluate formulae in a calculator including fractions and negative numbers

Rearrange formulae with fractions

Expand and simplify an expression involving brackets

A2.6 Evaluate formulae in a calculator including fractions and negative numbers e.g. Find the value of 5a-3b when a = $\frac{2}{3}$ and b = -2.	Rewrite the formula, replacing the letters with numbers. When putting into a calculator remember to use the fraction key and put any negative numbers into brackets e.g Rewrite the formula to be $5 \times \frac{2}{3} - 3 \times (-2)$ Type into calculator so it looks exactly like this $=\frac{28}{3}$ $or\ 9.\dot{3}$
A2.7 Rearrange formulae with fractions e.g Make x the subject of the formula $y = \frac{x}{5} + k$	Multiply each term by the denominator then use the same balancing method as when solving equations e.g $y = \frac{x}{5} + k$ (Multiply every term by 5) $5y = x + 5k$ (Subtract 5k from both sides) $5y - 5k = x$

A2.8 Expand and simplify an expression involving brackets e.g Expand and simplify $3(x + 2) + 2(x - 5)$ e.g Expand and simplify $3(x + 2) - 2(x - 5)$	To expand brackets multiply each term in the bracket by the term outside the bracket. Collect like terms together. Take care with negative signs. e.g $3(x + 2) + 2(x - 5)$ $=3x + 6 + 2x - 10$ $=5x - 4$ e.g $3(x + 2) - 2(x - 5)$ $=3x + 6 - 2x + 10$ $=x + 16$

A2: Formulae, Functions and Expressions

Factorise a quadratic expression where a=1
Use index rules for multiplying and Dividing
Use index rules for raising to a power

A2.9 Factorise a quadratic expression where a=1 e.g factorise $x^2 + 5x + 4$ e.g Factorise $x^2 - 3x - 4$	Work out two numbers that: Add to make the number in front of x; Multiply to make the number on its own. Write each bracket with an x and one of the numbers. Take care with negative numbers. e.g $x^2 + 5x + 4$ Add to make 5 Multiply to make 4 (x + 4)(x + 1) e.g $x^2 - 3x - 4$ Add to make -3 Multiply to make -4 (x - 4)(x + 1)

A2.10 Use Index rules for multiplying and dividing e.g Simplify $3a^2 \times 5a^7$ e.g Simplify $20c^8 \div 4c^3$	When multiplying the same base number with different indices, ADD the indices When dividing the same base number with different indices subtract the indices e.g Multiply the coefficients together and add the powers $=15a^9$ e.g Divide the coefficients and subtract the powers $=5c^5$
A2.11 Use index rules for raising to a power e.g simplify $(3y^2)^4$	Rewrite the calculation using the usual rules of indices then use the rules of multiplication to simplify e.g Rewrite as $3y^2 \times 3y^2 \times 3y^2 \times 3y^2$ Multiply the coefficients together and add the powers $=81y^8$

A2: Formulae, Functions and Expressions

Rearrange formulae with factorisation

Simplify algebraic fractions by factorisation

A2.12 Rearrange formulae with factorisation e.g. Make x the subject of the formula $ax = by + cx$	If there is more than one of the variable you're making the subject you will need to factorise. Move all of that variable to one side of the equation then factorise it out to leave you with only one of that variable e.g Move all the terms with x in them onto the same side $ax - cx = by$ Factorise out the x variable $x(a - c) = by$ Divide both sides by the created brackets $x = \frac{by}{a - c}$

A2.13 Simplify algebraic fractions by factorisation e.g Simplify $\frac{6x - 15}{9}$ e.g Simplify $\frac{x^2 + 7x + 12}{x^2 - 2x - 15}$	Start by factorising the numerator and denominator of the fraction. Then look for common factors that can be cancelled, these may be brackets or coefficients of brackets e.g Factorise the numerator $\frac{3(2x - 5)}{6}$ Cancel the common factor of 3 from the denominator and the multiplier of the brackets on the numerator $\frac{2x - 5}{2}$ e.g Factorise the numerator and denominator $\frac{(x + 3)(x + 4)}{(x + 3)(x - 5)}$ Cancel the matching brackets $\frac{(x + 4)}{(x - 5)}$

A2: Formulae, Functions and Expressions

Adding/Subtracting Algebraic fractions

Multiplying/Dividing algebraic fractions

Expand Triple Brackets

Substitute into a function using function notation

A2.14

Adding/Subtracting Algebraic Fractions

e.g

simplify $\frac{2x-4}{3} + \frac{3x+4}{5}$

Form a common denominator by using cross multiplication. Then add/subtract the numerator using the rules of algebra

e.g

Form a common denominator in the usual way

$$\frac{10x-20}{15} + \frac{9x+12}{15}$$

Add the numerators together

$$\frac{19x-8}{15}$$

A2.15

Multiplying/Dividing algebraic fractions

e.g

Simplify $\frac{x^2+2x-3}{x^2+4x+4} \div \frac{x^2+5x+6}{x^2-6x-16}$

Factorise the numerator/denominator of all fractions then follow the usual rules for multiplying/dividing, remembering to cross cancel

e.g

Factorise numerator and denominator and keep change flip $\frac{(x+3)(x-1)}{(x+2)(x+2)} \times \frac{(x+2)(x-8)}{(x+2)(x+3)}$

Cross cancel matching brackets

$$\frac{(x-1)(x-8)}{(x+2)(x+2)}$$

A2.16

Expand triple brackets

e.g

Expand and simplify

$(x+3)(x+4)(x-2)$

Expand two of the brackets using a grid then multiply the answer by the third bracket in another grid

e.g

Expand the first two brackets using a grid

x	x	$+3$
x	x^2	$+3x$
+4	$+4x$	$+12$

$=x^2+7x+12$

Then put this answer into another grid and expand with the third

x	x	$+7x$	$+12$
x	x^3	$+7x^2$	$+12x$
-2	$-2x^2$	$-14x$	-24

$=x^3+5x^2-2x-24$

A2.17

Substitute into a function using function notation

e.g

If $f(x) = x^2 - 5$ evaluate $f(4)$

Replace the letter in the bracket with the number in the bracket and calculate using BIDMAS

e.g

Replace the x ('s)in the formula with 4 and calculate

$$= 4^2 - 5$$
$$= 11$$

A2: Formulae, Functions and Expressions

Find the Inverse of a function

Find a compound function

A2.18 Find the inverse of a function	Replace the $f(x)$ notation with a y then rearrange the formula to make x the subject of the formula. Finally replace all y's in the formula with x's
e.g Find $f^{-1}(x)$ where $f(x) = 3x + 5$	e.g Replace f(x) with y $y = 3x + 5$ Rearrange the formula to make x the subject $x = \frac{y-5}{3}$ Replace all y's with x's $f^{-1}(x) = \frac{x-5}{3}$
e.g Find $f^{-1}(x)$where $f(x) = x^2 - 6$	e.g Replace f(x) with y $y = x^2 - 6$ Rearrange the formula to make x the subject $x = \sqrt{y+6}$ Replace all y's with x's $f^{-1}(x) = \sqrt{x+6}$

A2.19 Find a compound function	Work from right to left replacing the x's with the stated function.
e.g Find $fg(x)$ where $f(x) = 3x + 5$ and $g(x) = x^2 - 6$	e.g Working from right to left $g(x)$ needs to be substituted into $f(x)$ $fg(x) = 3(x^2 - 6) + 5$ Expand the brackets and simplify $fg(x) = 3x^2 - 13$
e.g Find gf(x) where $f(x) = 3x + 5$ and $g(x) = x^2 - 6$	e.g Working from right to left $f(x)$needs to be substituted into $g(x)$ $gf(x) = (3x + 5)^2 - 6$ Expand the brackets and simplify $gf(x) = 9x^2 + 30x + 19$

A3: Solving Equations and Inequalities

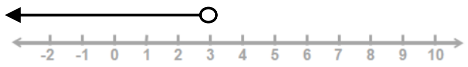
Solve Simple and two step linear equations

Solve Linear equations with brackets

Solve Linear equations with unknowns on both sides

Solve a linear inequality

A3.1 Solve simple and two step linear equations e.g. $2x - 3 = 7$ $\frac{x}{2} + 1 = 5$	e.g. $2x - 3 = 7$ (add 3 to each side) $2x = 10$ (divide both sides by 2) $\underline{x = 5}$ e.g. $\frac{x}{2} + 1 = 5$ (subtract 1 from each side) $\frac{x}{2} = 4$ (multiply both sides by 2) $\underline{x = 8}$
A3.2 Solve linear equations with brackets e.g. $3(4x + 1) = 15$ $2(5x - 4) = 12$	e.g. $3(4x + 1) = 15$ (expand the bracket) $12x + 3 = 15$ (subtract 3 from both sides) $12x = 12$ (divide both sides by 12) **$x = 1$** e.g. $2(5x - 4) = 12$ (expand the bracket) $10x - 8 = 12$ (add 8 to each side) $10x = 20$ (divide both sides by 10) **$x = 2$**

A3.3 Solve linear equations with unknowns on both sides e.g. $2a + 5 = a + 8$ $4a - 3 = 2a + 11$	e.g. $2a + 5 = a + 8$ (subtract a from both sides) $a + 5 = 8$ (subtract 5 from both sides) **$a = 3$** e.g. $4a - 3 = 2a + 11$ (subtract 2a from both sides) $2a - 3 = 11$ (add 3 to both sides) **$a = 7$**
A3.4 Solve a linear inequality e.g. $2x - 4 < 2$ $3x + 5 > 11$	e.g. $2x - 4 < 2$ (add 4 to both sides) $2x < 6$ (divide both sides by 2) **$x < 3$**  e.g. $3x + 5 > 11$ (add 4 to both sides) $3x > 6$ (divide both sides by 2) **$x > 2$** 

A3: Solving Equations and Inequalities

Display an inequality on a number line

Solve Linear Simultaneous Equations

A3.5 Display an inequality on a number line

e.g.

$x > -1$

$x < 4$

$x \le 7$

$x \ge 5$

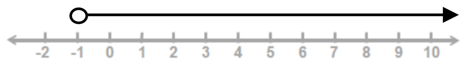
$4 < x \le 9$

A circle represents the number in the inequality. If the sign is > or < then the circle is not coloured in. If the sign is ≥ or ≤ then the circle is coloured in.

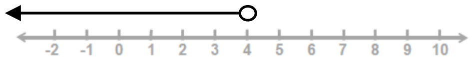
$x > -1$ (x is greater than -1)
$x < 4$ (x is less than 4)
$x \le 7$ (x is less than or equal to 7)
$x \ge 5$ (x is greater than or equal to 5)
$4 < x \le 9$ (x is greater than 4 and less than or equal to 9)

e.g.

$x > -1$

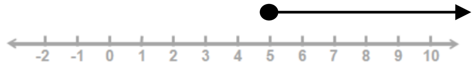


$x < 4$

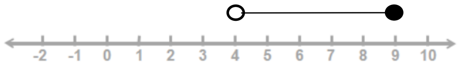


$x \le 7$

$x \ge 5$



$4 < x \le 9$



A3.6 Solve linear simultaneous equations

e.g.
Solve
$2x - 3y = 11$
$5x + 2y = 18$

Make the number in front of the y the same by multiplying the whole linear equation.

$2x - 3y = 11$ (x2)

$5x + 2y = 18$ (x3)

Add or subtract to eliminate y.

Same signs subtract.

Different signs add.

$4x - 6y = 22$

$15x + 6y = 54$

Solve the equation to find the value of x.

$19x = 76$

$x = 4$

Substitute the value of x into one of the equations to find the value of y.

$5(4) + 2y = 18$

$20 + 2y = 18$

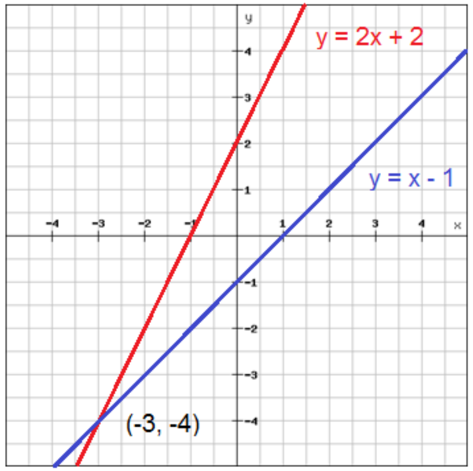
$2y = -2$

$y = -1$

A3: Solving Equations and Inequalities

Solving simultaneous equations graphically

Solve a quadratic equation by factorising when a=1

A3.7 Solving simultaneous equations graphically e.g. Solve y = 2x + 2 y = x - 1	Draw the graphs of the equations. Find out where they cross. The solution is the coordinates of the intersection point.  **x = -3** **y = -4**

A3.8 Solve a quadratic equation by factorising when a = 1 e.g. Solve $x^2 + 7x + 12$	**Write the equation in the form** **$ax^2 + bx + c = 0$.** $x^2 + 7x + 12 = 0$ **Factorise the left-hand side. Find two values that add to make b and multiply to make c.** Add to make 7 Multiply to make 12. Factors of 12 (12&1, 6&2, 3&4) (x + 3)(x + 4) = 0 **Equate each factor to 0 and solve for the values of x.** x + 3 = 0 (subtract 3 from both sides) X = -3 x + 4 = 0 (subtract 4 from both sides) X = -4 **x = -3** **or** **x = -4**

A3: Solving Equations and Inequalities

Solve a quadratic equation by factorising when a does not equal 1

Solve a quadratic equation using the quadratic formula

A3.9 Solve a quadratic equation by factorising when a does not equal 1 e.g. Solve $2x^2 + 7x + 3 = 0$	**Write the equation in the form** **$ax^2 + bx + c = 0$.** $2x^2 + 7x + 3 = 0$ **Factorise the left-hand side. Find two values that add to make b and multiply to make (c x a).** Add to make 7 *Multiply to make 3 x 2* Multiply to make 6 Factors of 6 (6&1, 3&2) 6 + 1 = 7 As a = 2, we must divide 6 by 2 to get 3. (2x + 1)(x + 3) = 0 **Equate each factor to 0 and solve for the values of x.** 2x + 1 = 0 (subtract 1 from both sides) 2x = -1 (divide both sides by 2) x = - ½ x + 3 = 0 (subtract 3 from both sides) X = -3 **x = - ½ or x = -3**

A3.10 Solve a quadratic equation using the quadratic formula $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ e.g. Solve $x^2 + 4x - 2$	**Write the equation in the form** **$ax^2 + bx + c = 0$.** $x^2 + 4x - 2 = 0$ **Write the values for a, b and c (including the sign)** a = 1, b = 4, c = -2 **Substitute the values for a, b and c into the formula** $x = \frac{-4 \pm \sqrt{(4^2 - 4 \times 1 \times -2)}}{2 \times 1}$ **Simplify to get the two values of x** $x = \frac{-4 \pm \sqrt{24}}{2}$ **$x = \frac{-4 + \sqrt{24}}{2} = 0.45$ (2dp)** **or** **$x = \frac{-4 - \sqrt{24}}{2} = -4.45$ (2dp)**

A3: Solving Equations and Inequalities

Solve a quadratic equation by completing the square

Solve linear /quadratic simultaneous equations using substitution

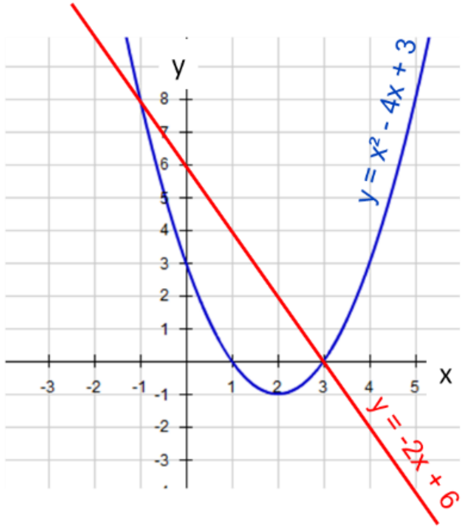
A3.11 Solve a quadratic equation by completing the square e.g. Solve $x^2 + 8x - 40$	**Write the equation in the form $ax^2 + bx + c = 0$.** $x^2 + 8x - 40 = 0$ **Write x + half the coefficient of x in brackets then square** $(x + 4)^2 - 40 = 0$ **Square and subtract the coefficient of x** $4^2 = 16$ $(x + 4)^2 - 16 - 40 = 0$ $(x + 4)^2 - 56 = 0$ **Now solve by adding the constant to both sides** $(x + 4)^2 - 56 = 0$ $(x + 4)^2 = 56$ **Square root both sides** $(x + 4)^2 = 56$ $x + 4 = \pm\sqrt{56}$ **Solve to find the two values of x** **$x = -4 - \sqrt{56} = -11.48$ (2dp)** **or** **$x = -4 + \sqrt{56} = 3.48$ (2dp)**

A3.12 Solve linear/quadratic simultaneous equations using substitution e.g. Solve Solve $x + y = 4$ and $x^2 + y^2 = 40$.	**Rearrange the linear equation** $x + y = 4$ $\underline{y = 4 - x}$ **Substitute the linear equation into the quadratic.** $x^2 + (4 - x)^2 = 40$. **Expand and simplify.** $(4 - x)^2 = x^2 - 8x + 16$ $x^2 + x^2 - 8x + 16 = 40$. $2x^2 - 8x + 16 = 40$ **Solve the quadratic by an appropriate method.** $2x^2 - 8x + 16 = 40$ $2x^2 - 8x - 24 = 0$ $(2x - 12)(x + 2) = 0$ $2x = 12$ **$x = 6$** **or** **$x = -2$** **Substitute the values found into the linear equation.** **<u>When x = 6, y = 4 – 6 = -2</u>** **<u>When x = -2, y = 4 - -2 = 6</u>**

A3: Solving Equations and Inequalities

Solve linear/quadratic simultaneous equations graphically

Use iteration to solve an equation

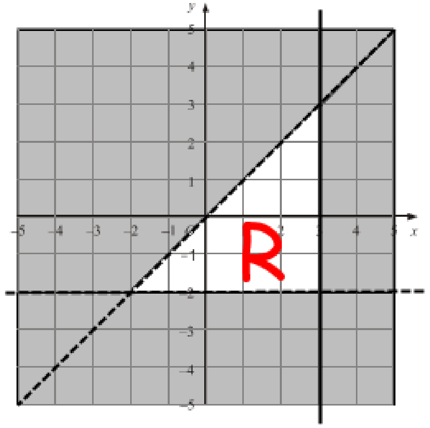
A3.13 Solve linear/quadratic simultaneous equations graphically e.g. Solve $y = x^2 - 4x + 3$ $y = -2x + 6$	Draw the graphs of the equations. Find out where they cross. The solutions are the coordinates of the intersection points.  **When x = -1 y = 8** **or** **When x = 3 y = 0**

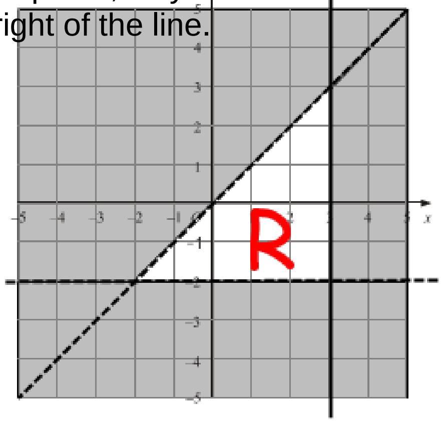
A3.14 Use iteration to solve an equation e.g. Using $x_{n+1} = 8 - \frac{5}{x_n^2}$ With $x_0 = 1$ Find the values of: x_1, x_2 , x_3 and x_4	**Input the value for x_0 into the formula to find the value for x_1.** $8 - \frac{5}{1^2} = 3$ $x_1 = 3$ **Input the value for x_1 into the formula to find the value for x_2.** $8 - \frac{5}{3^2} = \frac{67}{9}$ $x_2 = \frac{67}{9}$ **Input the value for x_2 into the formula to find the value for x_3.** $8 - \frac{5}{(\frac{67}{9})^2} = 7.909779461$ $x_3 = 7.909779461$ **Input the value for x_3 into the formula to find the value for x_4.** $8 - \frac{5}{(7.909779461)^2} =$ 7.920082617 $x_4 = 7.920082617$ $\boldsymbol{x_1 = 3}$ $\boldsymbol{x_2 = \frac{67}{9}}$ $\boldsymbol{x_3 = 7.909779461}$ $\boldsymbol{x_4 = 7.920082617}$

A3: Solving Equations and Inequalities

Represent an inequality graphically

Find a region on a graph defined by more than one inequality

A3.15 Represent an inequality graphically e.g. Represent the following inequalities graphically: x < y y > - 2 x ≤ 3	Plot each straight line. Use a broken line for < or >. Use a solid line for ≤ or ≥. Decide which side of the line to shade. Leave the required region unshaded. 

A3.16 Find a region on a graph defined by more than one inequality e.g. Find the region defined by the following inequalities: x < y y > - 2 x ≤ 3	**Decide which side of the line to shade – shade the section you do not want and leave the required region unshaded.** x < y (x is less than y) Area below the line is required, so you shade above the line. y > -2 (y is greater than -2) Area above the line is required, so you shade below the line. x ≤ 3 (x is less than or equal to 3) Area to the left of the line is required, so you shade to the right of the line. 

A3: Solving Equations and Inequalities

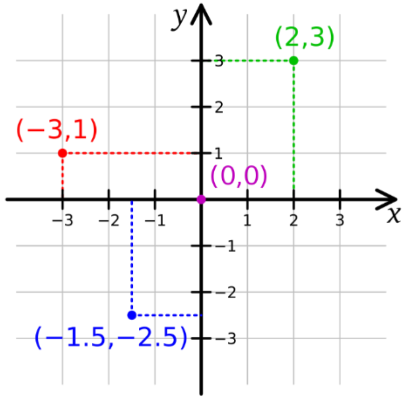
Use trial and improvement to solve an equation

A3.17 Use trial and improvement to solve an equation e.g. Use trial and improvement to solve the following equation to 1dp. $x^2 + 3x + 2 = 86$ has a solution between 7 and 8.	**Substitute different values for x into the equation until a value closest to the solution is found to the required degree of accuracy.** Solution between 7 and 8. Start with the midpoint of 7.5. $(7.5)^2 + 3(7.5) + 2 = 80.25$ *too small* $(7.6)^2 + 3(7.6) + 2 = 82.56$ *too small* $(7.7)^2 + 3(7.7) + 2 = 84.39$ *too small* $(7.8)^2 + 3(7.8) + 2 = 86.24$ *too big* <u>*Solution is between 7.7 and 7.8*</u> $(7.75)^2 + 3(7.75) + 2 = 85.3125$ *too small* The solution is between 7.75 and 7.8. Therefore to 1dp the solution is 7.8. **x = 7.8 to 1dp**

A4: Graphs 1

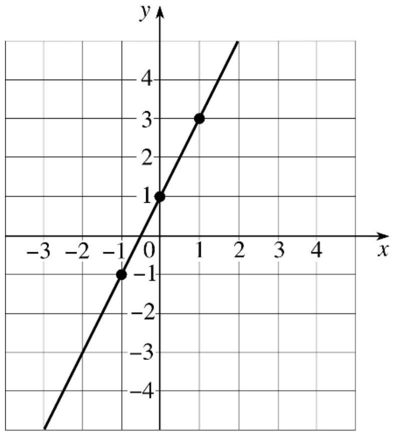
Plot coordinates in four quadrants

Plot a linear graph from a sequence or formula

A4.1 Plot coordinates in four quadrants e.g. Plot the origin (0,0) Plot the point (2,3) Plot the point (-3,1) Plot the point (-1.5, -2.5)	(x coordinate, y coordinate) For x, move right for positive values and left for negative. For y, move up for positive values and down for negative. e.g. 

A4.2 Plot a linear graph from a sequence or formula e.g. Plot the graph of y = 2x + 1	Draw a table of values by substituting values of x into the formula. Plot the points in pencil. Join the points with a ruler and pencil. They should be in a straight line. e.g. y = 2x + 1

x	-1	0	1
y	-1	1	3



A4: Graphs 1

Find the equation of vertical and horizontal lines

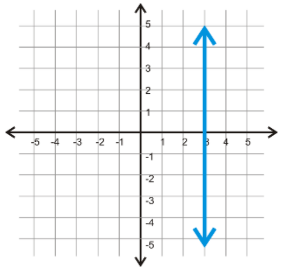
Find the equation of a line by considering the coordinates

A4.3

Find the equation of vertical and horizontal lines

Vertical lines have the form 'x = n' where n is the value where the line crosses the x axis.

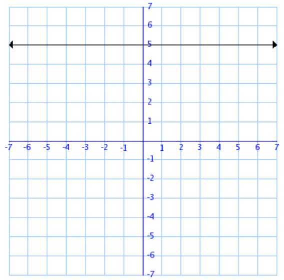
e.g.
Write the equation of this line



e.g.
this line is x = 3.

Horizontal lines have the form 'y = n' where n is the value where the line crosses the y axis.

Write the equation of this line



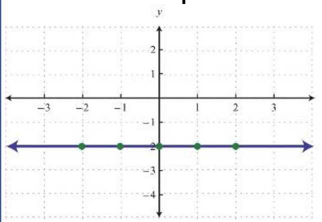
e.g.
this line is y = 5.

A4.4

Find the equation of a line by considering the coordinates

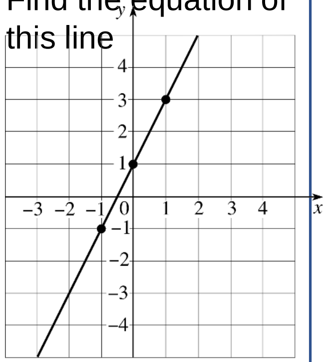
Select a set of coordinates from the line and compare the x and y values.
Use these to determine the equation of the line.

e.g.
Find the equation of



e.g. from this line you can get the coordinates
(-2,-2), (-1, -2), (0, -2), (1,-2), (2,-2)
In all of these the y coordinate is -2 so the equation of the line is
y = -2.

Find the equation of this line



From this line you can get the coordinates
(-2,-3), (-1, -1), (0,1), (1,3)
In all of these the y coordinate is found by multiplying the x coordinate by 2 and adding 1.
So the equation of the line is
y = 2x + 1.

A4: Graphs 1

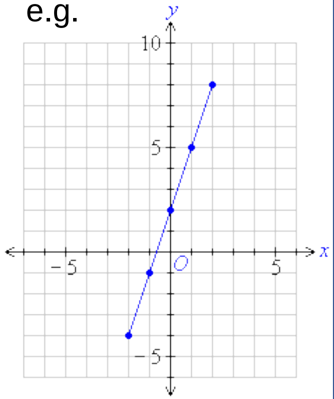
Identify the intercept of a graph

Calculate the gradient of a linear graph

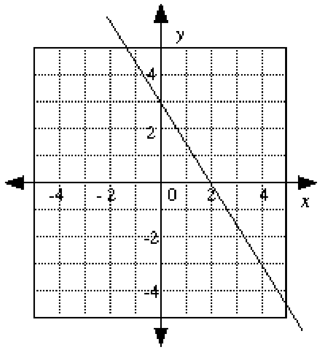
A4.5
Identify the intercept of a graph

The intercept of a graph is the value where the line crosses the y axis

e.g.



e.g.
this line crosses the y axis at 2, so the intercept of the graph is 2.



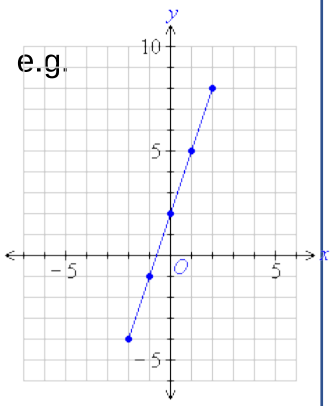
This line crosses the y axis at 3, so the intercept of the graph is 3.

A4.6
Calculate the gradient of a linear graph

Identify the coordinates of two points on the graph. The gradient is calculated using the formula

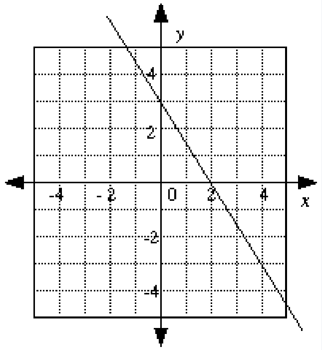
Gradient = $\frac{Change\ in\ y\ coordinates}{Change\ in\ x\ coordinates}$

e.g.



e.g. from this line you can get the coordinates (2,7) and (1,5).

Gradient = $\frac{7-5}{2-1} = \frac{2}{1}$ = 2.



From this line you can get the coordinates (0,3) and (2,0).

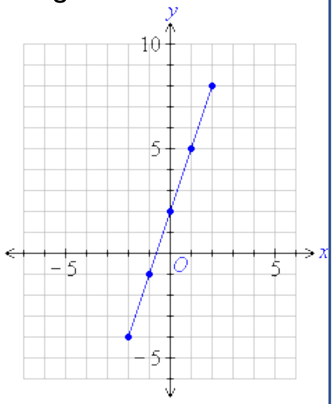
Gradient = $\frac{3-0}{0-2} = \frac{3}{-2}$ = -1.5.

A4: Graphs 1

Calculate the gradient of a line segment between two points

Construct the equation of a line

A4.7 Calculate the gradient of a line segment between two points e.g. Find the gradient of the line segment between the points (0,3) and (2,9) Find the gradient of the line segment between the points (2,7) and (5,1)	The gradient is calculated using the formula Gradient = $\frac{Change\ in\ y\ coordinates}{Change\ in\ x\ coordinates}$ e.g. Gradient = $\frac{9-3}{2-0}$ = $\frac{6}{2}$ = 3. Gradient = $\frac{7-1}{2-5}$ = $\frac{6}{-3}$ = -2.

A4.8 Construct the equation of a line e.g. 	The equation of a straight line is given by y = mx + c. m is the gradient. c is the intercept. e.g. Gradient = $\frac{5-2}{1-0}$ = $\frac{3}{1}$ = 3. Intercept = 2. y = mx + c. y = 3x + 2.
A4.9 Find the gradient of a line parallel to a given line e.g. Find a line parallel to y = 3x - 1	Parallel lines have the same gradient. Give the equation of a line with same gradient. The intercept can be any value. e.g. Any line with a gradient of 3 y = 3x y = 3x +6

A4: Graphs 1

Plot a quadratic Graph

Plot and Use Distance Time Graphs

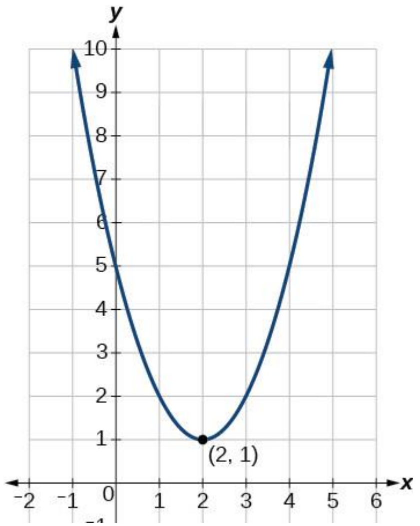
A4.11
Plot a quadratic graph

Draw a table of values by substituting values of x into the formula.
Plot the points in pencil.
Join the points with a ruler and pencil.
They should be in a smooth curve

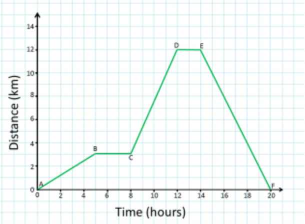
e.g. $y = x^2 - 4x + 5$

e.g.
Plot the graph of
$y = x^2 - 4x + 5$

x	-1	0	1	2	3	4	5
y	10	5	2	1	2	5	10



A4.12
Plot and use distance time graphs



From the graph explain what happens between:
A and B;
B and C;
E and F.

Where is the speed the greatest?

Plot distance on the vertical axis.
Plot time on the horizontal axis.
Speed is calculated using
Speed = $\frac{Distance\ Travelled}{Time\ taken}$.

e.g.
Between A and B, 3 km are travelled in 5 hours.

Between B and C, no distance is travelled during the 3 hour period.

Between E and F, 12 km are travelled in 6 hours.

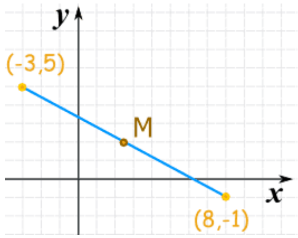
The greatest speed occurs where the line is the steepest. This between C and D.

You can also calculate speed:
A to B 3 ÷ 5 = 0.6 km per hour;
C to D 9 ÷ 4 = 2.25 km per hour;
E to F 12 ÷ 6 = 2 km per hour;

A4: Graphs 1

Find the coordinates of the midpoint of a line segment

Find the equation of a line passing through a given point, parallel to a given line

A4.13 Find the coordinates of the midpoint of a line segment e.g. Find the midpoint of this line segment  	Draw the line segment and identify the coordinates of the point at the halfway position. Alternatively, use the coordinates of the ends of the line segment. x coordinate of the midpoint is the mean average of the x coordinates of the end points, i.e. (-3 + 8) ÷ 2 = 2.5. y coordinate of the midpoint is the mean average of the y coordinates of the end points, i.e. (5 + -1) ÷ 2 = 2.

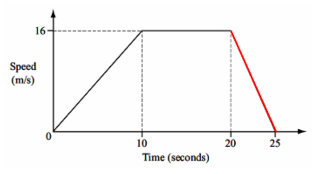
A4.14 Find the equation of a line passing through a given point, parallel to a given line e.g. Find the equation of the line parallel to y = 3x – 1 that passes through the point (2, 7)	If the lines are parallel, the gradient is the same for both. Use y = mx + c. e.g. Gradient = 3. When x = 2, y = 7. y = mx + c. 7 = 3 x 2 + c c = 1 y = 3x + 1.

Plot and use speed time graphs

Find the gradient of a line perpendicular to another line

A4.15
Plot and use speed time graphs

e.g.



From the graph explain what happens between:
0 and 10 seconds;
10 and 20 seconds;
20 and 25 seconds.

Plot speed on the vertical axis.
Plot time on the horizontal axis.
Acceleration is calculated using
Acceleration = $\frac{Change\ in\ speed}{Time}$.

e.g.
Between 0 and 10 seconds, speed increased from 0 to 16 m/s in 10 seconds.
Acceleration = 16 ÷ 10 = 1.6 m/s^2.

Between 10 and 20 seconds, speed remains constant.
Acceleration = 0 m/s^2.

Between 20 and 25 seconds, speed decreased from 16 to 0 m/s in 10 seconds.
Acceleration = -16 ÷ 5 = -3.2 m/s^2.

A4.16
Find the gradient of a line perpendicular to another line

e.g.
Find the gradient of a line perpendicular to the line y = 5x + 4

Find the gradient of a line perpendicular to the line y = -2x + 4

When two lines are perpendicular, the product of their gradients is -1.

Find the gradient of the given line.
Find the reciprocal and change the sign.
This is the gradient of the perpendicular line.

e.g.
Gradient of y = 5x + 4 is 5.
Negative reciprocal is -1/5 or -0.2.
Gradient of perpendicular is -0.2.

Gradient of y = -2x + 4 is -2.
Negative reciprocal is ½ or 0.5.
Gradient of perpendicular is ½.

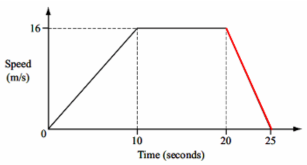
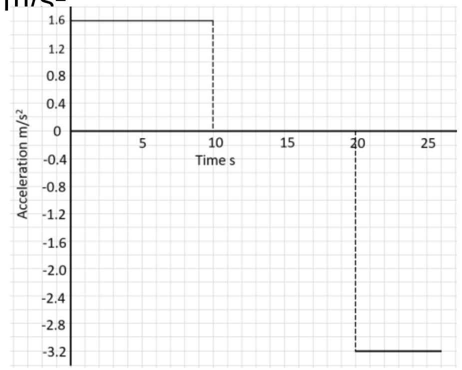
A4: Graphs 1

Find the equation of a line passing through a given point, perpendicular to a given line

Find the equation of a perpendicular bisector to a line segment

Plot and use acceleration time graphs

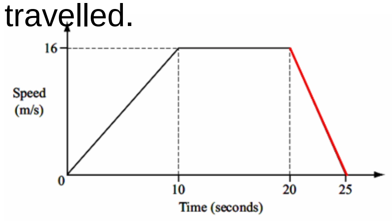
A4,17 Find the equation of a line passing through a given point, perpendicular to a given line e.g. Find the equation of the line perpendicular to y = ½ x + 3 that passes through the point (2, 7)	If the lines are perpendicular, the product of their gradients is -1. Use y = mx + c. e.g. Gradient of given line = ½ . Gradient of perpendicular = -2. When x = 2, y = 7. y = mx + c. 7 = -2 x 2 + c c = 11 y = -2x + 11.
A4.18 Find the equation of a perpendicular bisector to a line segment e.g. Find the equation of the perpendicular bisector of the line segment joining the points (0, 7) and (4,5).	Find the gradient and midpoint of the line segment. Find the gradient of a line perpendicular to the line segment. Use y = mx + c. e.g. Gradient of line = $\frac{7-5}{0-4}$ = -½ . Gradient of perpendicular = 2. Midpoint of given line is (2, 6). y = mx + c. 6 = 2 x 2 + c c = 2 y = 2x + 2.

A4.19 Plot and use acceleration time graphs e.g. Plot an acceleration time graph for this speed time graph 	Plot acceleration on the vertical axis. Plot time on the horizontal axis. e.g. Between 0 and 10 seconds, acceleration = 16 ÷ 10 = 1.6 m/s^2. Between 10 and 20 seconds, acceleration = 0 m/s^2. Between 20 and 25 seconds, acceleration = -16 ÷ 5 = -3.2 m/s^2 

A4: Graphs 1

Relate gradient of a line or curve to rate of change

Relate the area under a speed time graph to distance

A4.20 Relate gradient of a line or curve to rate of change.	The gradient of a line gives the rate of change of the variables. On a distance time graph, it shows the rate of change of distance with respect to time, i.e. speed. On a speed time graph, it shows the rate of change of speed with respect to time, i.e. acceleration.
A4.21 Relate the area under a speed time graph to distance.	The area under a speed time graph gives the distance travelled.  In the example, the distance travelled in the first 10 seconds is the area of the triangle. Distance travelled = (16 x 10) ÷ 2 = 80m.

A5: Sequences

Continue a sequence using a term to term rule
Generate a linear sequence using a term to term rule
Generate e linear sequence using nth term
Find the nth term of a linear sequence

A5.1
Continue a sequence using a term to term rule

1 5 9 13
This is the start of a sequence.
Each individual digit is called a term.
Using a term to term rule carry on the sequence.
What are the next two numbers of this sequence?

1 5 9 13
+4 +4 +4

Term to term rule = +4
The sequence can be carried On by adding 4.
The next two numbers are 17 and 21

A5.2
Generate a linear sequence using term to term rule

(i) A sequence has a starting term of 8 and a term to term rule of +3. Generate the sequence

(ii) A sequence has a starting term of 8 and a term to term rule of -3. Generate the sequence

(i) 8 11 14 17 20 ….
+3 +3 +3

(ii) 8 5 2 -1 -4
-3 -3 -3 -3

A5.3
Generate a linear sequence using nth term

If the nth term of a sequence is **5n+1** what are the 1st, 2nd and 3rd terms of the sequence?

Replace n by each of the numbers 1, 2 and 3 in turn.

If the nth term is **5n+1**
1st term (n=1) = 5 x **1** + 1 = 6
2nd term (n=2) = 5 x **2** + 1 = 11
3rd term (n=3) = 5 x **3** + 1 = 16
The sequence begins 6, 11, 16
The terms have a difference of 5 which matches the 5n in the formula.

A5.4
Find the nth term of a linear sequence

The position to term rule allows us to write a rule for any term in the sequence from its position.

Find the nth term for the sequence 4, 10, 16, 22

Position	1	2	3	4
Term	4	10	16	22

+6

+6 means that the rule for this sequence contains 6n.
1 x 6 – 2 =4
2 x 6 – 2 = 10
3 x 6 – 2 = 16
Term = position x 6 – 2
Term = n x 6 – 2
nth term = 6n - 2

A5: Sequences

Continue sequence of square numbers
Continue sequence of cube numbers
Relate sequences to patterns
Plot a linear graph from a sequence or formula

A5.5
Continue sequence of square numbers

A square number is obtained by multiplying a number by itself e.g. 1 x 1 = 1
2 x 2 = 4

1, 4, 9, 16, 25
is the start of a sequence of square numbers.
How can this sequence be continued?

1 4 9 16 25
+3 +5 +7 +9
+2 +2 +2

The first line of differences is the set of odd numbers beginning with 3.
The second line of differences is a constant 2.
Each term is the square of its term number.

A5.6
Continue sequence of cube numbers

A cube number is obtained by multiplying a number by itself three times e.g. 1 x 1 x 1 = 1
2 x 2 x 2 = 8

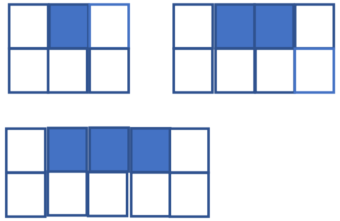
1, 8, 27, 64, 125
is the start of a sequence of cube numbers.
How can this sequence be continued?

1 8 27 64 125
+7 +19 +37 +61
+12 +18 +24
+6 +6

If we calculate the first line of differences and continue with the second we find that the third line of differences is a constant 6.
Each term is the cube of its term number.

A5.7
Relate sequences to patterns

This is a sequence of diagrams showing black tiles *b* and white tiles *w*.
How many white tiles are there when there are 8 black tiles?



Find a formula for w in terms of b

b	1	2	3
W	5	6	7

Using the rule for sequences w = b + 4

Therefore when b = 8
w = 8 + 4
w = 12

A5.8
Plot a linear graph from a sequence or formula

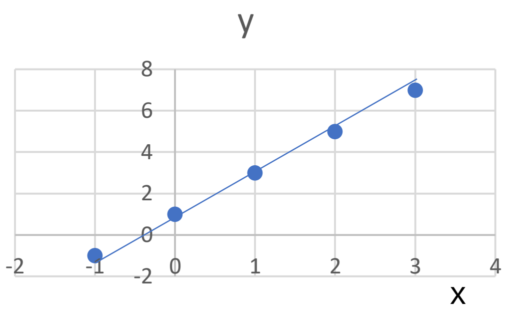
Plot the graph of the formula
y = 2x + 1

First make a table of values +
y = 2 x -1 + 1 = -1
y = 2 x 0 + 1 = 1 etc

Y = 2x + 1

x	-1	0	1	2	3
y	-1	1	3	5	7

Now plot x and y values as co-ordinate points and join with a straight line.



A5: Sequences

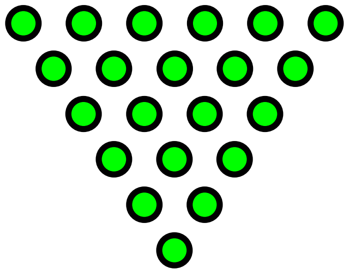
Recognise and continue sequence of triangular numbers

Recognise and continue Fibonacci type sequences

Identify arithmetic and geometric type sequences

Identify a quadratic sequence

A5.9
Recognise and continue sequence of triangular numbers



1, 3, 6, 10, 15, …. is the start of the sequence of triangular numbers.

The difference between the terms is +2, +3, +4, +5 and this can be used to continue the sequence.

The 1st row of the triangle is 1, the 1st triangle number.
Adding the 1st + 2nd rows of the triangle gives 1 + 2= 3 which is the 2nd triangle number
Adding the 1st+2nd+3rd rows gives 1 + 2 + 3 = 6 which is the 3rd triangle number and so on.

A5.10
Recognise and continue Fibonacci type sequences

0, 1, 1, 2, 3, 5, 8, 13, …

This is the Fibonacci sequence. How can this sequence be continued?

To continue the Fibonacci sequence add each term to the previous term to generate the next one e.g.
0 + 1 = 1
1 + 1 = 2
1 + 2 = 3
2 + 3 = 5
3 + 5 = 8
5 + 8 = 13
8 + 13 = 21 which is the next term in the sequence.

A5.11
Identify arithmetic and geometric type sequences

In an **Arithmetic sequence** the same amount (common difference) is added on to each term to continue the sequence.

In a **Geometric sequence** every term is multiplied by the same amount (common ratio) to continue the sequence.

Are the following arithmetic or geometric sequences?

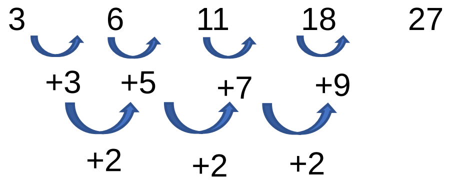
(i) 2, 6, 18, 54, ….
(ii) 5, 8, 11, 14, 17 …..
(iii) 256, 128, 64, 32, ……
(iv) 42, 38, 34, 30, 26, …..

(i) Geometric: common ratio x3
(ii) Arithmetic: common difference +3
(iii) Geometric: common ratio x 0.5
(iv) Arithmetic: common difference
(v) -4

A5.12
Identify a quadratic sequence

3 6 11 18 27

This sequence does not have a common difference on the first line of Differences so we continue to the second row of differences.



The 1st row of differences has a common difference of 2 so this is a quadratic sequence.

A5: Sequences

Use the nth term to write a quadratic sequence

A5.13
Use the nth term to write a quadratic sequence

A **quadratic** sequence always contains a squared term.
The nth term of a quadratic sequence is $2n^2 + n + 1$.

Write down the first 5 terms of this sequence.

$2n^2 + n + 1.$

$$2 \times 1^2 + 1 + 1 = 4$$
$$2 \times 2^2 + 2 + 1 = 11$$
$$2 \times 3^2 + 3 + 1 = 22$$
$$2 \times 4^2 + 4 + 1 = 37$$
$$2 \times 5^2 + 5 + 1 = 56$$

So the sequence is
4, 11, 22, 37, 56
....

A5.14
Find the nth term of a quadratic sequence

Find the nth term of the sequence
4, 13, 26, 43, 64

If the 2nd line of differences
is 2 rule is n^2
is 4 rule is $2n^2$
is 6 rule is $3n^2$
is 8 rule is $4n^2$

4 13 26 43 64
+9 +13 +17 +21
+4 +4 +4

The 2nd line of differences is 4 so the rule contains $2n^2$

Term no:	1	2	3	4
Term:	4	13	26	43
$2n^2$:	2	8	18	32
Subtract:	2	5	8	11

This sequence has a rule 3n-1 so the whole rule is

$$2n^2 + 3n - 1$$

A6: Graphs 2

Plot a graph of a cubic function

Identify and plot a reciprocal graph

A6.1

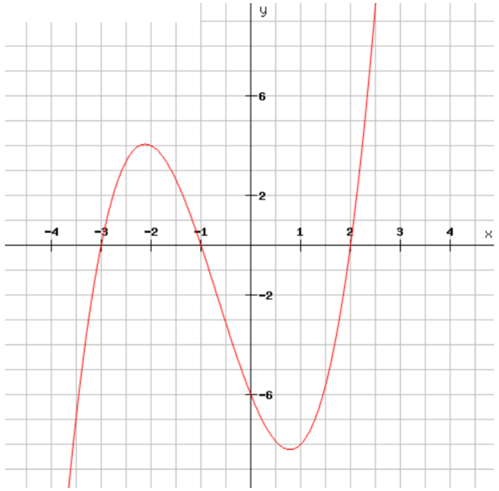
Plot a graph of a cubic function

Draw a table of values by substituting values of x into the formula.
Plot the points in pencil.
Join the points with a ruler and pencil.
They should be in a smooth curve

e.g.
Plot the graph of
$y = x^3 + 2x^2 - 5x - 6$.

e.g. $y = x^3 + 2x^2 - 5x - 6$.

x	-3	-2	-1	0	1	2
y	0	4	0	-6	-8	0



A6.2

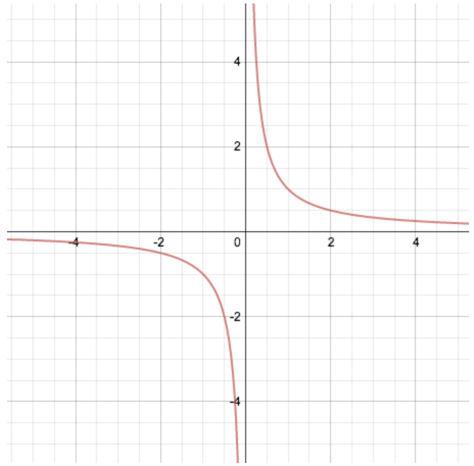
Identify and plot a reciprocal graph

Draw a table of values by substituting values of x into the formula.
Plot the points in pencil.
Join the points with a ruler and pencil.
They should be in smooth curves as in the example, $y = \frac{1}{x}$.

The axes are asymptotes.

e.g.
Plot the graph of
$y = \frac{1}{x}$.

x	-4	-2	-1	-0.5	0.5	1	2	4
y	-0.25	-0.5	-1	-2	2	1	0.5	0.25



A6: Graphs 2

Identify and plot a exponential graph

Know the graph of sine

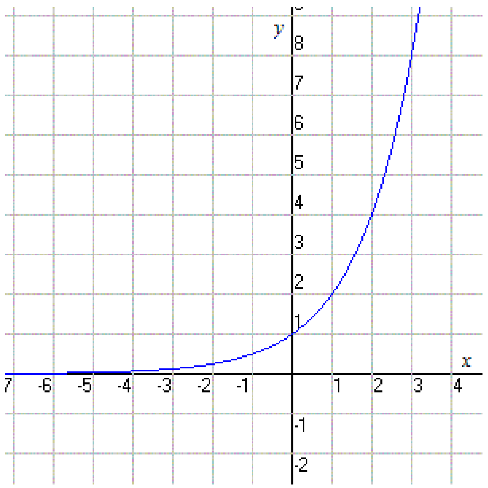
Know the graph of cosine

A6.3 Identify and plot an exponential graph

Draw a table of values by substituting values of x into the formula.
Plot the points in pencil.
Join the points with a ruler and pencil.
They should be in a smooth curve
e.g. $y = 2^x$.

e.g.
Plot the graph of
$y = 2^x$.

x	-3	-2	-1	0	1	2	3
y	1/8	¼	½	1	2	4	8

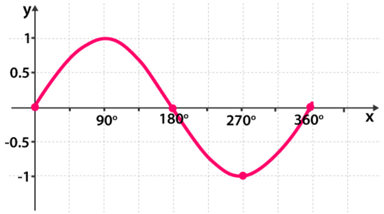


A6.4 Know the graph of sine

For the Sine function between 0 and 360^o, the main values are

x	0	90	180	270	360
y	0	1	0	-1	0

giving this curve

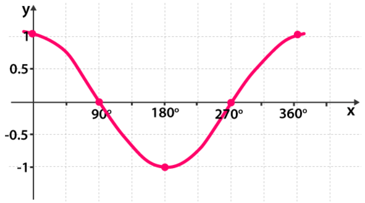


Know the graph of cosine

For the Cosine function between 0 and 360^o, the main values are

x	0	90	180	270	360
y	1	0	-1	0	1

giving this curve



A6: Graphs 2

Know the graph of tangent

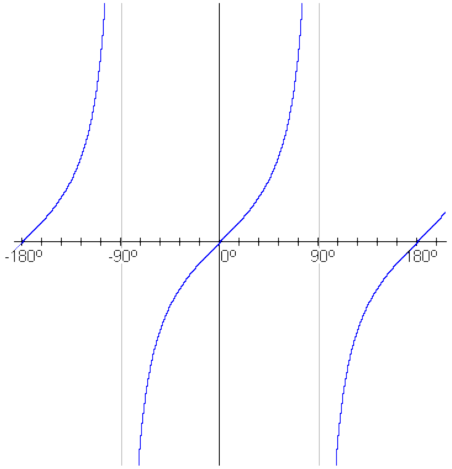
Translate a graph f(x+a) and f(x) +a

A6.5
Know the graph of tangent

For the Tangent function between -180º and 180º, the main values are

x	-180	-135	-45	0	45	135	180
y	0	1	-1	0	1	-1	0

There are asymptotes at -90º and 90º.
The graph of tangent is

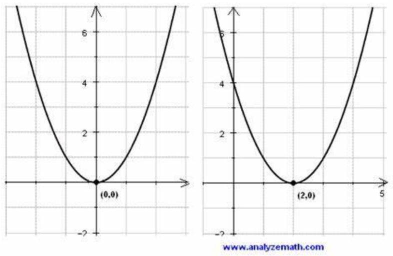


Graph of the Tangent Function

A6.6
Translate a graph f(x + a) and f(x) + a

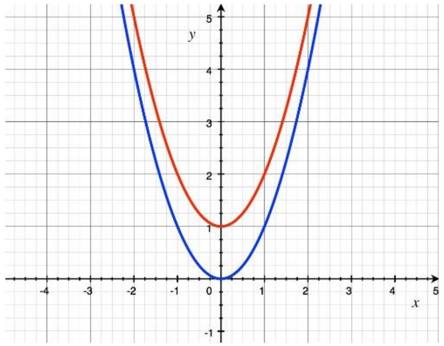
e.g. y = f(x – 2)

y = f(x + a).
Translates the graph (-a) steps along the x-axis.
e.g. y = f(x – 2) translates y = f(x)
2 units along the x axis, to the left.



y = f(x) + 1

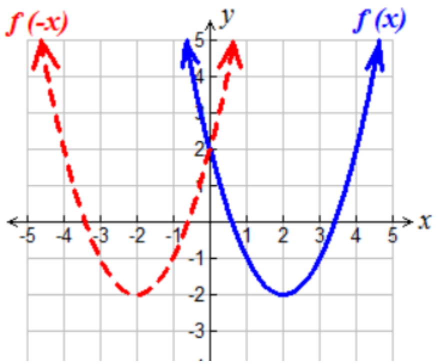
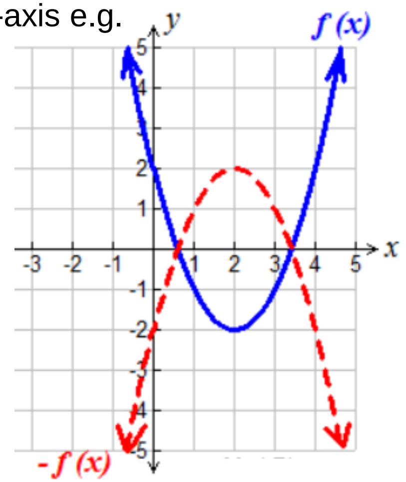
y = f(x) + a.
Translate the graph a steps along the y-axis.
e.g. y = f(x) + 1 translates y = f(x)
1 unit up along the y=axis.

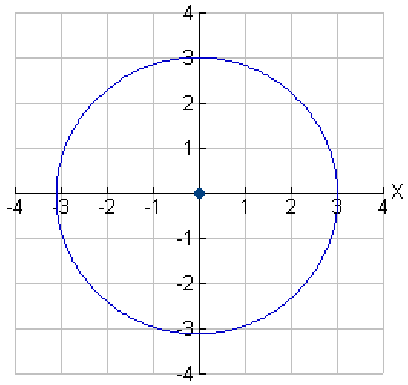


A6: Graphs 2

Reflect a graph f(-x) and –f(x)

Know and plot the graph of a circle

A6.7 Reflect a graph f(-x) and -f(x) e.g. y = f(-x)	**y = f(-x).** Reflects the graph of f(x) in the y-axis e.g. 
y = -f(x)	**y = -f(x).** Reflects the graph of f(x) in the x-axis e.g. 

A6.8 Know and plot the graph of a circle e.g. plot the graph of the circle $x^2 + y^2 = 9$.	The graph of a circle is of the form: $x^2 + y^2 = r^2$ where r is the radius and the centre is (0,0). e.g. $x^2 + y^2 = 9$ $x^2 + y^2 = 3^2$ This a circle of radius 3 and centre (0,0). 

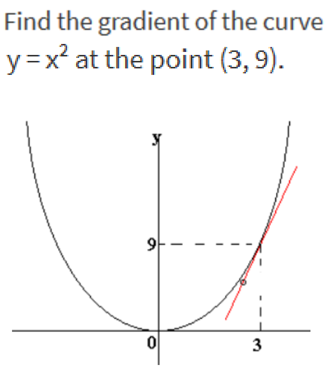
A6: Graphs 2

Estimate the gradient of a curve using a tangent

Estimate the area under a curve using trapezia

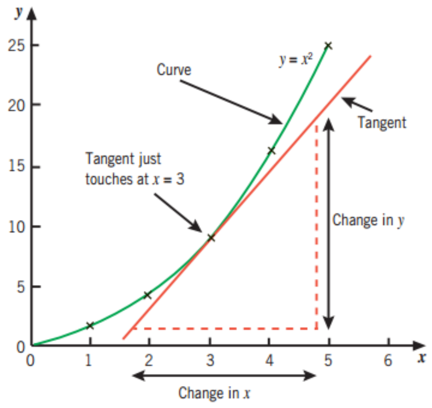
A6.9

Estimate the gradient of a curve using a tangent



To estimate the gradient of a curve at a given point, draw a tangent to the curve at that point.
Find the gradient of the tangent.

e.g. estimate the gradient of the curve $y = x^2$ at the point (3,9).

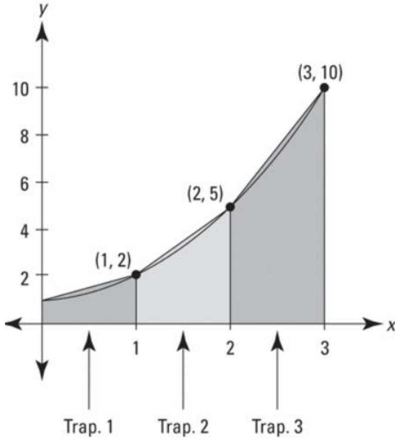


A6.10

Estimate the area under a curve using trapezia

e.g.
estimate the are under the curve
$y = x^2 + 1$ between
$x = 0$ and $x = 3$.

Divide the area under the curve into trapezia of equal width.
More accuracy is gained by using more trapezia.

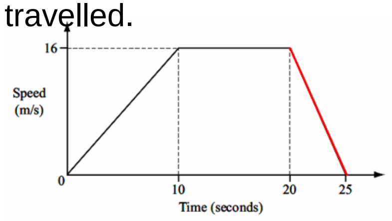


Calculate the area of each trapezium and add them for the area under the curve.
Trap 1: ½ (1 + 2)1 = 1.5 square unit.
Trap 2: ½ (2 + 5)1 = 3.5 square units.
Trap 3: ½ (5 + 10)1 = 7.5 square units.
Area
= 1.5 + 3.5 + 7.5
= 12.5 square units.

A6: Graphs 2

Relate gradient of a line or curve to rate of change

Relate the area under a speed time graph to distance

A6.11 Relate gradient of a line or curve to rate of change.	The gradient of a line gives the rate of change of the variables. On a distance time graph, it shows the rate of change of distance with respect to time, i.e. speed. On a speed time graph, it shows the rate of change of speed with respect to time, i.e. acceleration.
A6.12 Relate the area under a speed time graph to distance.	The area under a speed time graph gives the distance travelled.  In the example, the distance travelled in the first 10 seconds is the area of the triangle. Distance travelled = (16 x 10) ÷ 2 = 80m.

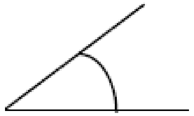
G1: Angles, Similarity and Congruency

Identifying types of angle

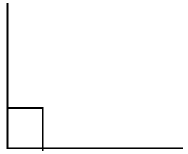
Drawing an angle

G1.1 Identifying types of angle

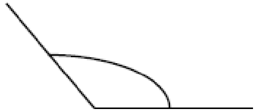
Acute (less than 90°)



Right (Exactly 90°)



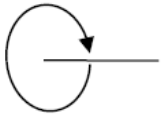
Obtuse (Between 90° & 180°)



Straight line (180°)

Reflex (Between 180° & 360°)

Complete turn (360°)

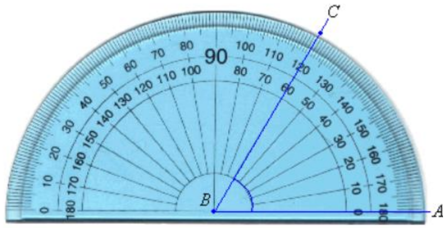


G1.2 Drawing an angle

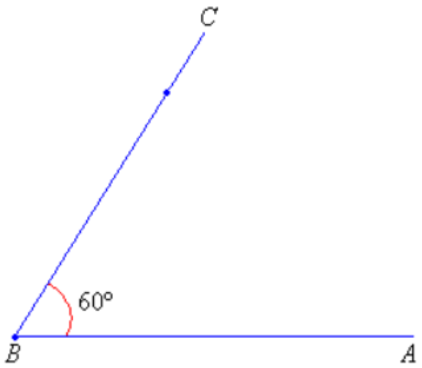
e.g. Draw an angle of 60°

Draw a straight line

Place your protractor on either end of the line and using the appropriate scale find 60 degrees and put a



Join the end of the line you measured from and the dot you drew.



A6: Graphs 2

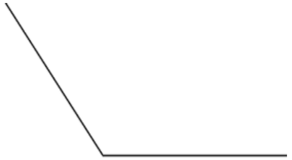
Measuring angles

Know and use angles on a straight line

G1.2

Measuring angles

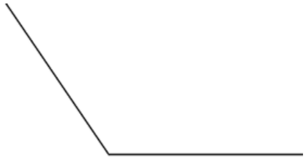
e.g. measure the following angle.

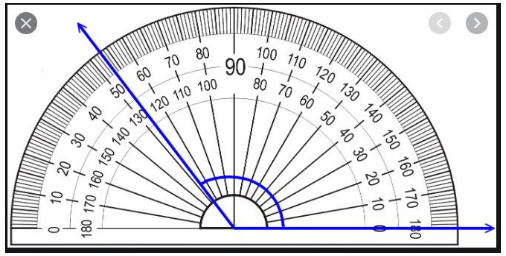


Place the midpoint of the protractor on the VERTEX of the **angle**.

Line up one side of the **angle** with the zero line of the protractor (where you see the number 0).

Read the degrees where the other side crosses the number scale.





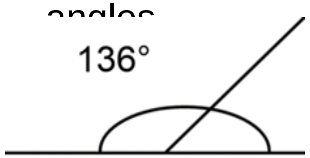
= 126°

G1.3

Know and use angles on a straight line.

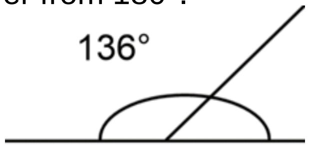
e.g.

Find the missing angles



Angles on a straight line add up to 180°

Find the total of the given angles and subtract your answer from 180°.



180 - 136 = 44°

124 + 42 = 166

180 – 166 = 14°

A6: Graphs 2

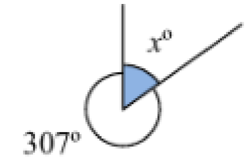
Know and use angle sums of a point

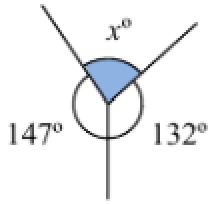
Know and use the corresponding angle rule

G1.4

Know and use angle sums at a point

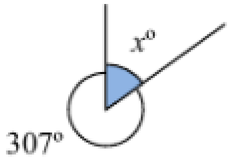
e.g. Find the missing angles



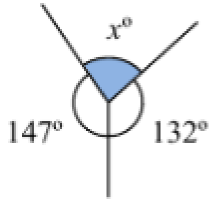


Angles at a point add up to 360°

Find the total of the given angles and subtract your answ



360 – 307 = 53°

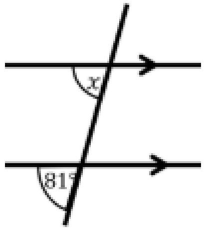


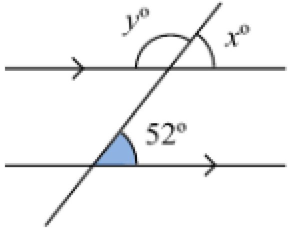
147 + 132 = 279
360 – 279 = 81°

G1.5

Know and use the correspondin g angle rule

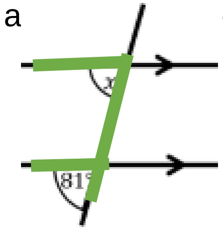
e.g. find the x in each of the following questions



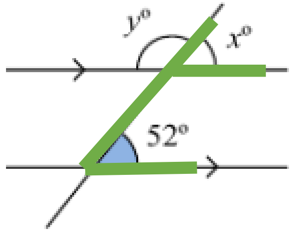


Corresponding angles are equal.

You need to be able to join the angles with an **F** shape. It can be a of an **F**.



X = 81°



X = 52°

A6: Graphs 2

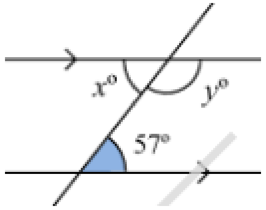
Know and use the alternate angle rule

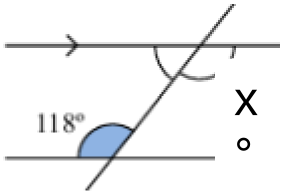
Know and use the vertically opposite angle rule

G1.6

Know and use the alternate angle rule

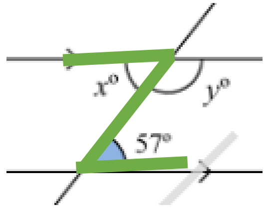
e.g. Find the x in the following questions



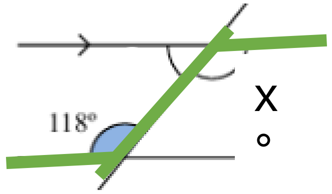


Alternate angles are equal.

You need to be able to join the angles with an **Z** shape. It can be any orientation of an **Z.**



X = 57°

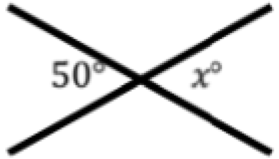


X = 118°

G1.7

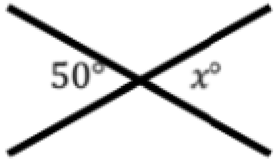
Know and use the vertically opposite angle rule

e.g. Find the missing angle in each of these



Vertically opposite angles are equal.

The **angles opposite** each other when two lines cross. They are always equal.



X = 50°

X = 171°

A6: Graphs 2

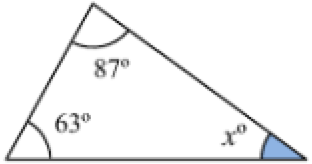
Know and use the interior angles in a triangle

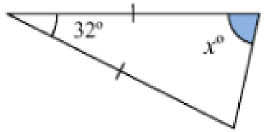
Know and use the sum of interior angles in a quadrilateral

G1.8

Know and use the sum of interior angles in a triangle

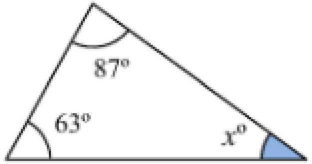
e.g. Calculate the missing angle in each of the folllowing questions.



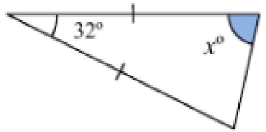


Angles in a triangle add up to 180°

Find the total of the given angles and subtract your answer from 180°.



63 + 87 = 150
180 – 150 = 30°

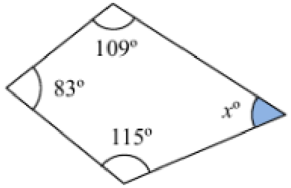


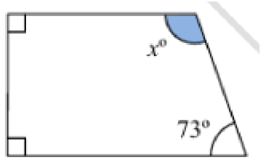
This is a special triangle called an Isosceles triangle. In an Isosceles triangle the base angles are equal. We still take the given angles away from 180, but we halve the answer afterward.
180 – 32 = 148
148 ÷ 2 = 74°

G1.9

Know and use the sum of interior angles in a quadrilateral

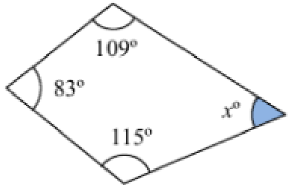
e.g. Calculate the missing angle in each of the folllowing questions.



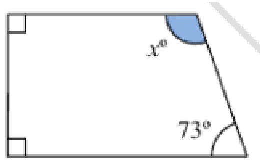


Angles in a quadrilateral add up to 360°

Find the total of the given angles and subtract your answer from 360°.



109 + 83 + 115 = 307
360 – 307 = 53°



73 + 90 + 90 = 253
360 – 253 = 107°

A6: Graphs 2

Know and use the sum of internal angles of a polygon

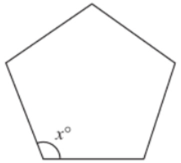
Identify congruent shape using the simple definition of congruency

G1. 10

Know and use the sum of internal angles of a polygon

e.g.

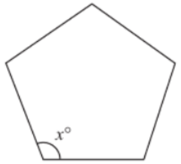
Calculate the sum of internal angles of the following shape.



Calculate the sum of interior angles in a Hexagon

A **polygon** is a 2d shape formed by straight lines. The formula for finding the sum of the **measure** of the **interior angles** is (n - 2) x 180.

n represents the number of sides the shape has.



(5 – 2) x 180 = 540°

Calculate the sum of interior angles in a Hexagon

A hexagon has 6 sides.

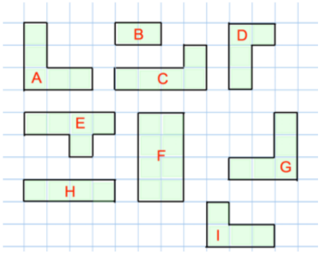
(6 – 2) x 180 = 720°

G1. 11

Identify congruent shapes using the simple definition of congruency.

e.g.

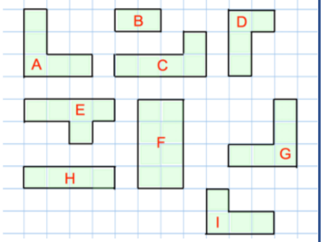
List all the congruent pairs of shapes.



Congruent shapes have the same size and **shape**. This means that the sides and segments of two **shapes** have the same length. And, the angles possess the same measurements

If one shape can be made from another using Rotations, Reflections, or Translations then the shapes are Congruent.

e.g. List the congruent pairs of shapes.



A and G
D and I

A6: Graphs 2

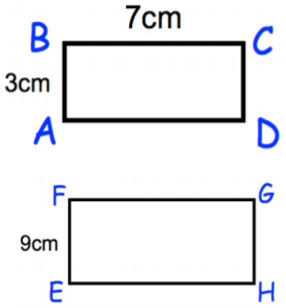
Use similarity to find missing lengths

Know and use the sum of external angles of a regular polygon

G1. 12

Use similarity to find missing lengths.

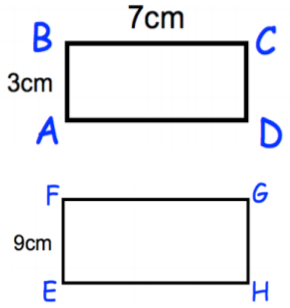
e.g. Rectangle ABCD and EFGH are mathematically similar.



Calculate the length of FG

When two shapes are **similar**, the ratios of the lengths of their corresponding sides are equal. Similar shapes are enlargements of each other.

e.g.



Rectangle ABCD and EFGH are mathematically simil ar. Calculate the length of FG.

The scale factor to get from 3cm to 9cm is 3. Which means you must multiply the other sides by 3 also.

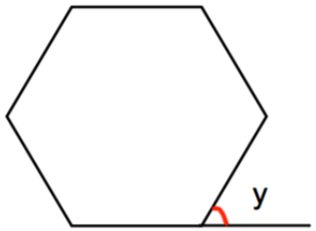
Therefore 7 x 3 = 21cm

FG=21cm

G1. 13

Know and use the sum of external angles of a regular polygon

e.g.

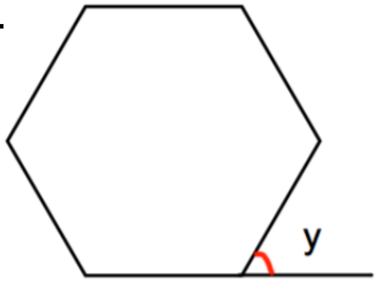


Calculate the size of angle y

The sum of **exterior angles of any polygon** is 360°. The formula for calculating the size of an **exterior angle of a regular polygon** is:

exterior angle of a regular polygon = 360 ÷ number of sides.

e.



y= 360 ÷ 6 = 60°

A6: Graphs 2

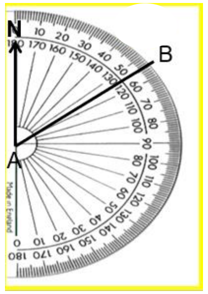
Read a bearing

Draw a bearing

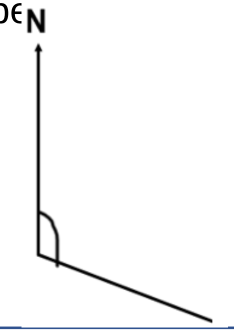
G1. 14

Read a bearing

e.g. Measure the bearing from A to B



Measure the following be



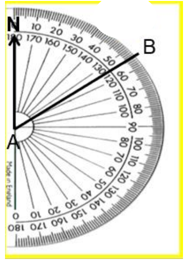
A **bearing** is used to represent the direction of one point relative to another point

There are 3 rules to follow when measuring a bearing:

- Measure from north
- Measure clockwise
- Writing using 3 digits

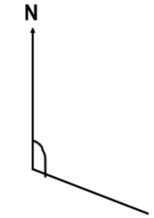
e.g. Measure the bearing from A to B.

= 054°



Measure the following bearing

= 110°



G1. 15

Draw a bearing

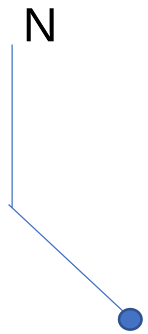
e.g. Draw a bearing of 130°

A **bearing** is used to represent the direction of one point relative to another point.

To draw a bearing of 130° you need to;

- Draw a North line

- Measure 130° from the north line and join.



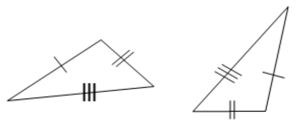
A6: Graphs 2

Prove Congruency using ASA SAS SSS and RHS

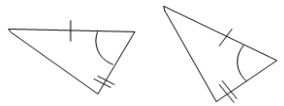
Use similarity to find missing areas

G1. 16 Prove congruency using ASA,SAS,SSS and RHS

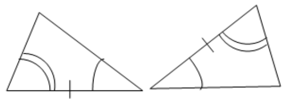
Congruent shapes have the same size and shape.
One will fit exactly over the other.
2 triangles are congruent if any of these 4 conditions are satisfied on each triangle.



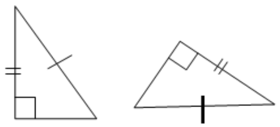
The corresponding sides are equal, SSS



2 sides and the included angle are equal, SAS



2 angles and the included side are equal, ASA

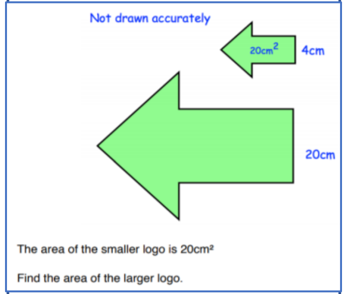


Both triangles are right angled, the hypotenuses are the same length and another pair of sides are equal, RHS.

G1. 17

Use similarity to find missing areas

e.g. find the missing area



Similar figures are identical in shape, but not necessarily in size. A missing length, area or volume on a reduction/enlargement figure can be calculated by first finding the scale factor.

We already know that if two shapes are similar their corresponding sides are in the same ratio and their corresponding angles are equal. When calculating a missing area, we need to calculate the Area Scale Factor.

Area Scale Factor (ASF) = (Linear Scale Factor)^2

Area Scale Factor (ASF) = 5^2

Area scale factor = 25

So the area of the new shape is;

area of old shape x area scale factor

= 20 x 25
= $500cm^2$

A6: Graphs 2

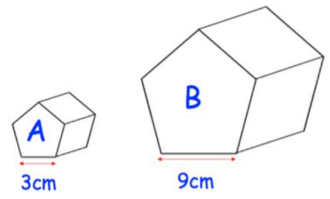
Use similarity to find missing volumes

G1. 19

Use similarity to find missing volumes

e.g. Calculate the missing volume

Below are two similar pentagonal prisms.



The volume of prism A is 15cm³
Work out the volume of prism B.

Similar figures are identical in shape, but not necessarily in size. A missing length, area or volume on a reduction/enlargement figure can be calculated by first finding the scale factor.

We already know that if two shapes are similar their corresponding sides are in the same ratio and their corresponding angles are equal.

When calculating a missing volume, we need to calculate the Volume Scale Factor.
Volume Scale Factor (VSF) = (Linear Scale Factor)^3

Volume Scale Factor (VSF) = 3^3

VSF = 27

So the volume of the new shape is;

Volume of old shape
x
Volume scale factor

15 x 27 = 405cm^3

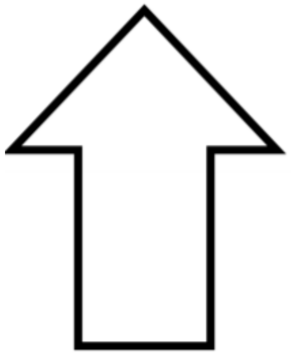
G2: 2D Shapes

Identify Line Symmetry
Identify Rotational Symmetry

G2.1

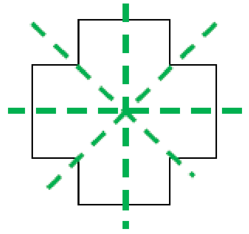
Identify line symmetry

e.g.
Draw the lines of symmetry on the following shape.



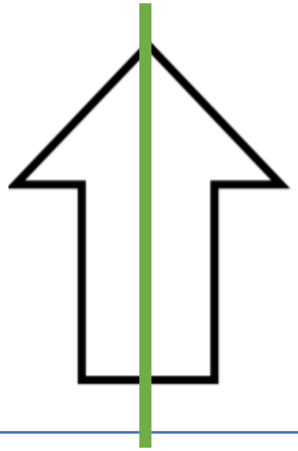
- **Order of Line Symmetry**

this is the number of times a shape can be folded so that one side falls exactly onto the other side



This shape has line symmetry ORDER 4

e.g. Draw the lines of symmetry on the following shape

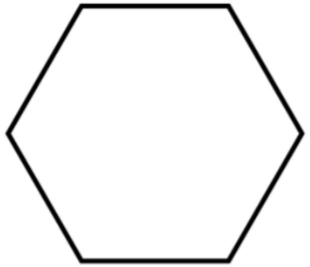


G2.2

Identify rotational symmetry

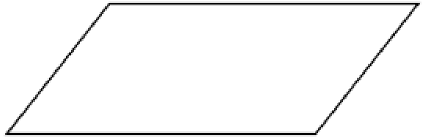
e.g.

State the order of rotational symmetry of the following shape (regular hexagon)



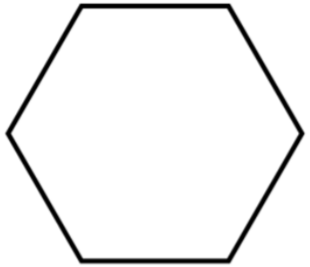
- **Order of Rotational Symmetry**

this is the number of times a shape falls into its outline in one complete turn



A parallelogram has rotational symmetry order 2

e.g. State the order of rotational symmetry of the following shape (regular hexagon)



Rotational symmetry order 6

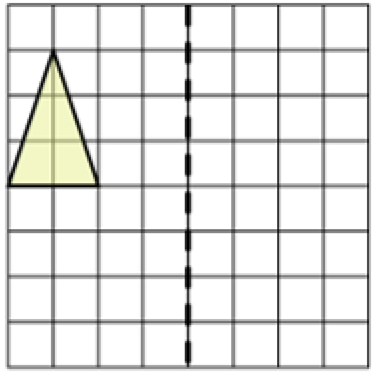
G2: 2D Shapes
Reflect a Shape
Describe a reflection

G2.3

Reflect a shape

e.g.

Reflect the shape in the given mirror line



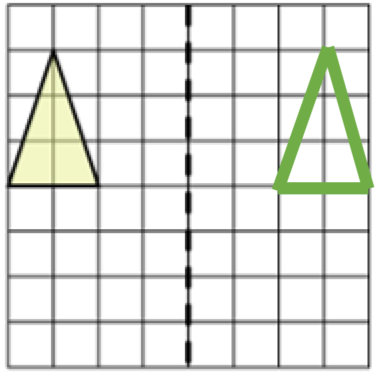
A shape can be **reflected** across a line of reflection to create an image.

The line of reflection is also called the mirror line.

Reflection is an example of a **transformation**. A transformation is a way of changing the size or position of a shape.

Every point in the image is the same distance from the mirror line as the original shape.

e. g. Reflect the shape in the given mirror line

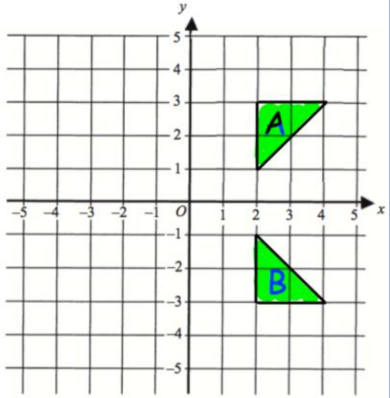


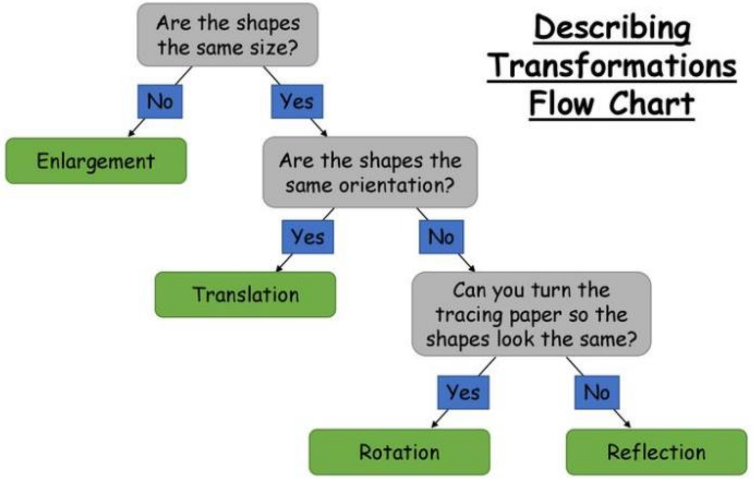
G2.4

Describe a reflection

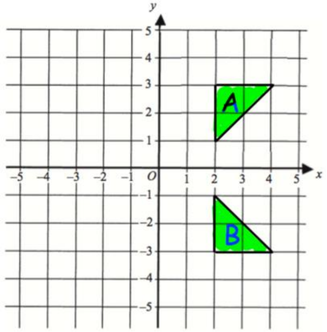
e.g.

Describe fully the single transformation that maps A onto B.





e.g. Describe fully the single transformation that maps A onto B.



Using the flow chart you can work out that it is a **reflection**, you then need to calculate where the mirror line is. To do this you need to find the line that is equidistant from each shape. In this case the mirror line is the **x-axis. So it is a reflection in the x-axis.**

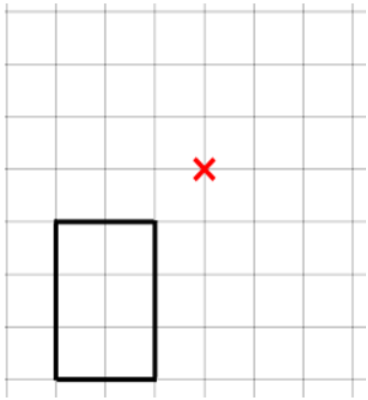
G2: 2D Shapes
Rotate a shape
Describe a rotation

G2.5

Rotate a shape

e.g.

Rotate the following shape 90° clockwise

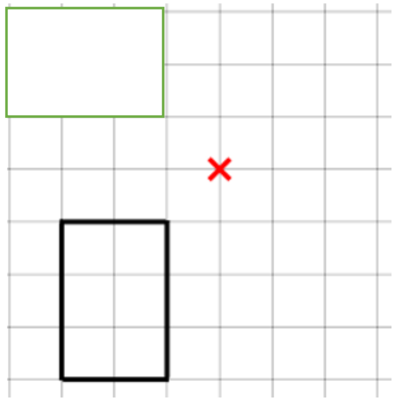


A **rotation** is a turn of a shape.

A rotation is described as the angle of **rotation**, and the direction of the turn.

- 90° is a quarter turn
- 180° is a half turn
- Clockwise is the same direction a clock turns
- The opposite to clockwise

e.g. Rotate the following shape 90° clockwise

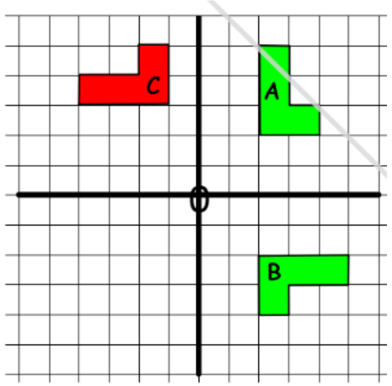


G2.6

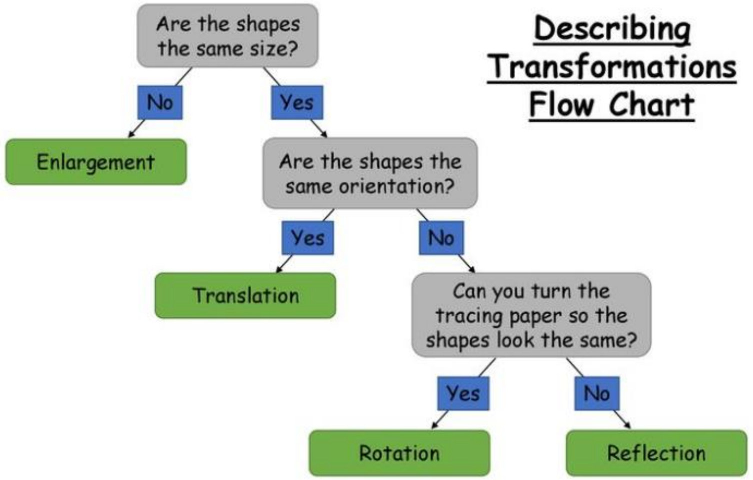
Describe a Rotation

e.g.

Describe the following transformation



A to B:
A to C:



Follow the flow diagram to see which of the transformations it is: Rotation

Calculate the angle and direction of rotation:

A to B: Rotation, 90° clockwise

A to C: Rotation 90° anti clockwise

G2: 2D Shapes

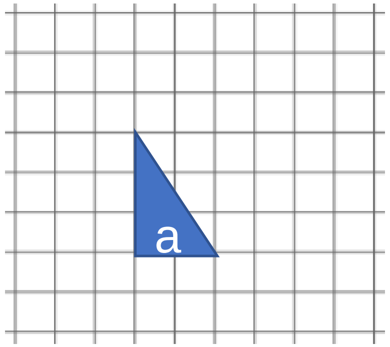
Translate a shape

Describe a translation

G2.7

Translate a shape

e.g. Translate the following shape 2 left and 1 up



A **translation** moves a shape up, down or from side to side but it does not change its appearance in any other way.

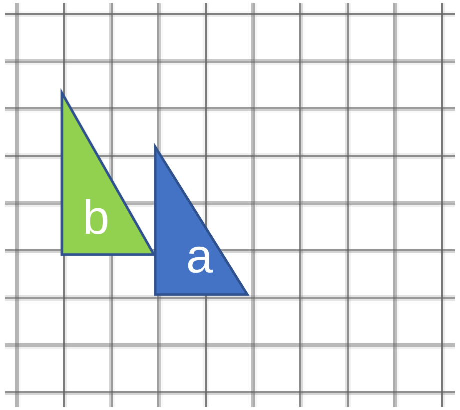
Translation is an example of a **transformation**. A transformation is a way of changing the size or position of a shape.

Every point in the shape is translated the same distance in the same direction.

You are given to instructions to move the shape;

- Left or right
- Up or down

Translate the following shape 2 left and 1 up

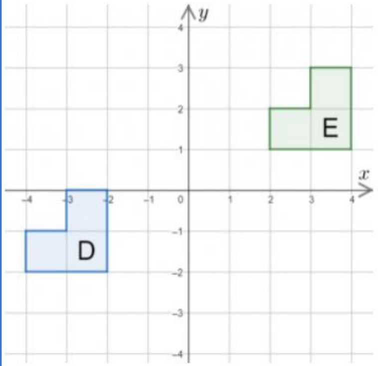


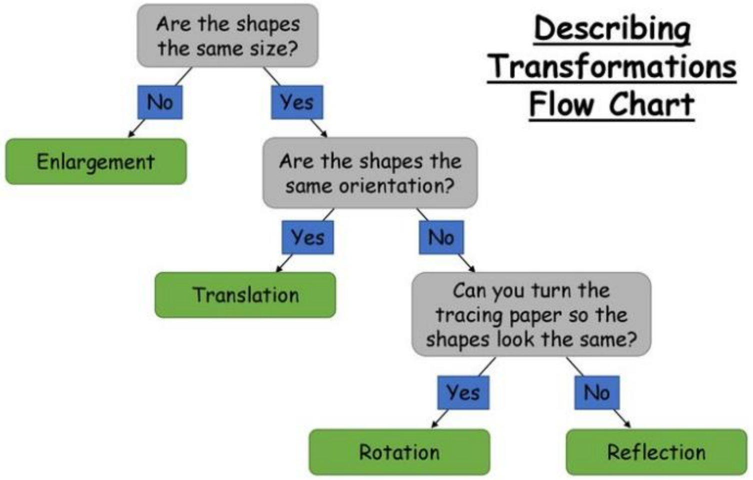
G2.8

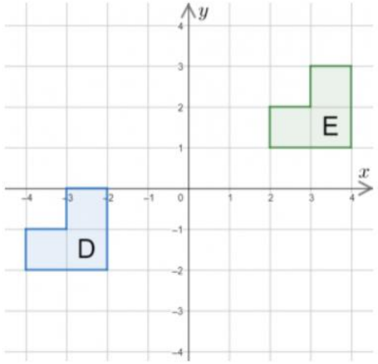
Describe a Translation

e.g.

Describe the following translation to map shape d to shape e.







e.g. describe the following translation to map shape d to shape e.

6 right and 3 up

G2: 2D Shapes

Enlarge a shape by an integer scale factor

Describe an enlargement by an integer scale factor

G2.9

Enlarge a shape by an integer scale factor

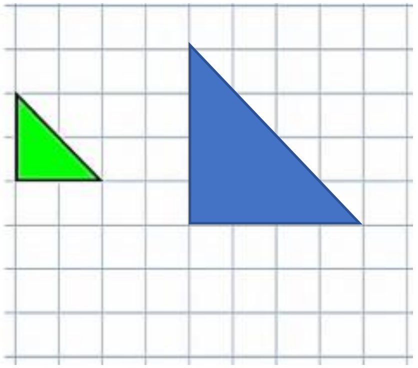
e.g. Enlarge the following shape by a scale factor of 2

Enlarging a shape changes its size.

When enlarging a shape you need to know by how much. This is called the **scale factor**. For example, a **scale factor** of 2 means that you multiply each side of the shape by 2.

An enlargement with positive scale factor greater than 1 increases the size of the enlarged shape.

e.g. Enlarge t
scale factor o

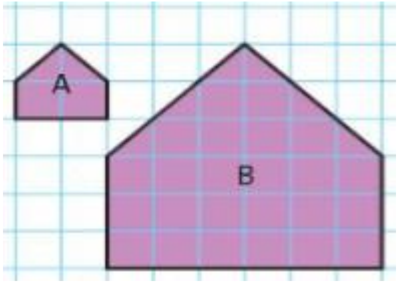


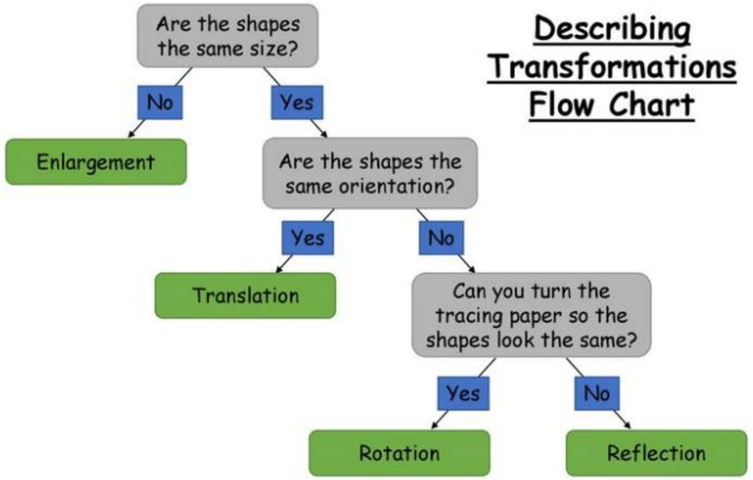
Multiply each of the sides of the shape by 2 and re-draw.

G2.10

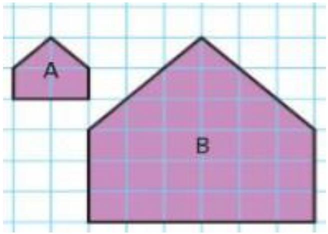
Describe an enlargement by an integer scale factor

e.g. Describe the following transformation that maps shape A to B.





e.g. Describe the following transformation that maps A to B



Follow the flow diagram to see which of the transformations it is. **Enlargement.**

To find the Scale Factor you see what each side has been multiplied by. In this case it's **3.**

The transformation is **Enlargement SF. 3.**

G2: 2D Shapes

Calculate the perimeter of a rectangle

Calculate the area of a rectangle

G2.11

Calculate the perimeter of a rectangle

e.g.

Calculate the perimeter of the following rectangle

The **perimeter** is the length of the outline of a shape. To find the **perimeter** of a rectangle or square you have to add the lengths of all the four sides

e.g.

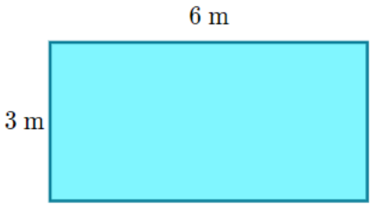
Calculate the perimeter of the following rectangle

Perimeter = 5+5+3+3= 16in

G2.12

Calculate the area of a rectangle

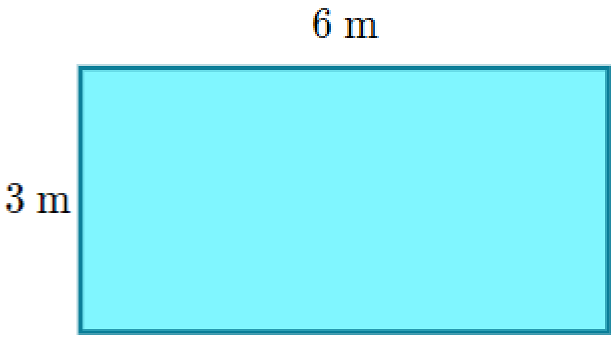
e.g. Calculate the area of the following rectangle



A shape's **area** is the number of square units it takes to completely fill it. In a rectangle you find it by multiplying the width by the height.

Formula: Width × Height

e.g. Calculate the area of the following rectangle



Area = width x height

Area = 6 x 3

Area = $18m^2$

G2: 2D Shapes

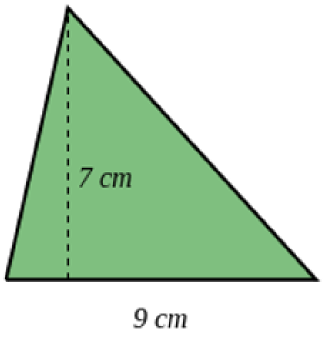
Calculate the area of a triangle Calculate the area of a parallelogram

G2.13

Calculate the area of a triangle

e.g.

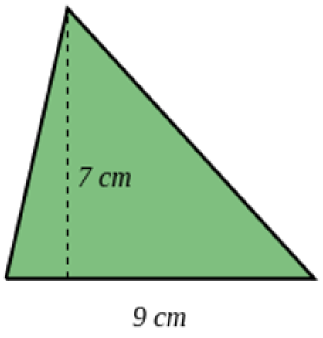
Calculate the area of the following triangle



A shapes **area** is the number of square units it takes to completely fill it. In a triangle you find it by multiplying the base by the height (perpendicular), then dividing your answer by 2.

Area of a triangle = $\frac{base \ X \ height}{2}$

e.g. Calculate the area of the following triangle



Area of triangle = $\frac{9 \ X \ 7}{2}$

Area of triangle = $\frac{63}{2}$

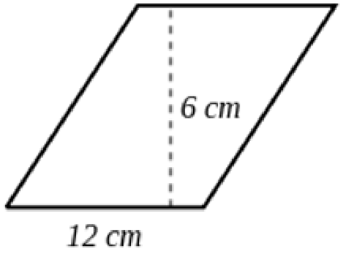
= 31.5cm^2

G2.14

Calculate the area of a parallelogram

e.g.

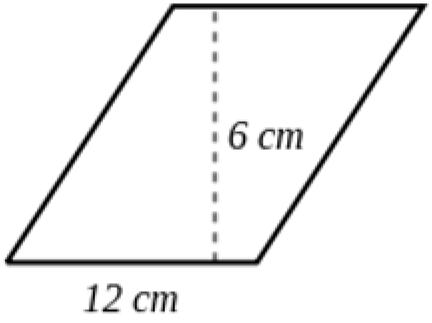
Calculate the area of the following parallelogram



A shapes **area** is the number of square units it takes to completely fill it. In a parallelogram you find it by multiplying the width by the height.

Area of a parallelogram = width x height

e.g. Calculate the area of the following parallelogram



Area of parallelogram = 12 x 6

Are of parallelogram = 72cm^2

G2: 2D Shapes

Calculate missing sides from areas

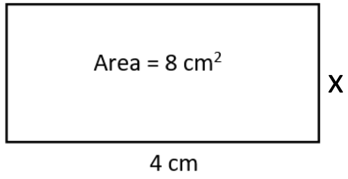
Read a timetable

G2.15

Calculate missing sides from areas

e.g.

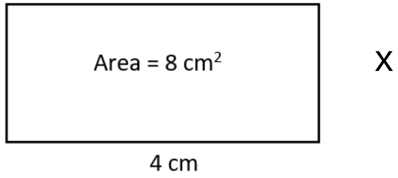
Calculate the missing side of the following shape.



To find missing lengths of rectangles you first need to remember the formula to find the area which is:

Area = width x length

What you need to do is rearrange the formula, so what you are looking for is the subject.



In this case you are looking for the length so you rearrange the formula to make it the subject.

Length = area ÷ width
Length = 8 ÷ 4
= 2cm

Shortcut:
With a rectangle or square you just divide the area by the side that you are given.

G2.16

Read a timetable

e.g. **Read & interpret timetables**

Station	Time of leaving
Peterborough	08 44
Huntingdon	09 01
St Neots	09 08
Sandy	09 15
Biggleswade	09 19
Arlesey	09 24

e.g. Time taken to travel from Peterbrough to Sandy

0844 0900 0915

16min + 15min = 31min

To read a timetable such as the one in the example, you look at the “time of leaving” column. This states the time that the particular mode of transport leaves that particular place.

G2: 2D Shapes

Use Metric measures of length

Convert metric units of length

G2.17

Use metric measures of length

We can measure how long things are, or how tall, or how far apart they are. Those are all examples of length measurements.

Small units of length are called **millimetres**.
A **millimetre** is about the thickness of a plastic id card (or credit card).

When we have 10 millimetres, it can be called a **centimetre**.
1 centimetre = 10 millimetres
A fingernail is about **one centimetre wide**.

We can use millimetres or centimetres to measure how tall we are, or how wide a table is, but to measure the length of a football pitch it is better to use **metres**.

A **metre** is equal to 100 centimetres.
1 metre = 100 centimetres

The length of a guitar is about 1 **metre**
Metres can be used to measure the length of a house, or the size of a playground.

A **kilometre** is equal to 1000 metres.
The distance from one city to another or how far a plane travels can be measured using **kilometres**.

G2.18

Convert metric units of length

e.g.

Convert:

100mm to cm
170cm to m
6700m to km

10mm	**1cm**
100cm	1m
1000	1km

e.g. convert:

100mm to cm
Divide by 10 =10cm

170cm to m
Divide by 100 =1.7m

6700m to km
Divide by 1000 =6.7km

To work the other way i.e. cm to mm you do the inverse i.e. multiply by 10.

G2: 2D Shapes
Use Metric measures of mass
Convert metric units of mass

G2.19 Using metric units for mass	Mass: how much matter is in an object. We measure mass by weighing, but weight and mass are not really the same thing. These are the most common measurements: • Grams • Kilograms • Tonnes Grams are the smallest, Tonnes are the biggest. Grams are often written as g (for short), so "300 g" means "300 grams". A loaf of bread weighs about 700 g When we have 1000g, we have 1kilogram, written short as 1kg. Scales measure our mass using kilograms. An adults mass can be about 70 kg. But when it comes to things that are very heavy, we need to use the tonne. Once we have 1,000 kilograms, we will have 1 tonne. Some cars can have a mass of around 2 tonnes

G2.20

Convert metric units of mass

e.g.

Convert:

5500g into kg

9870kg into tonnes

1000g	**1kg**
1000kg	1 tonne

e.g. convert:

5500g to kg
Divide by 1000 = 5.5kg

9870kg to tonnes
Divide by 1000 =9.87 tonnes

To work the other way i.e. kg to g you do the inverse i.e. multiply by 1000.

G2: 2D Shapes

Use Metric measures of volume or capacity

Convert metric units of volume or capacity (litres only)

G2.21 Use metric units of volume or capacity	Volume is the amount of 3-dimensional space something takes up. The two most common measurements of volume are: • Millilitres • Litres A **millilitre** is a very small amount of liquid, 5 ml can be held within a teaspoon. A **litre** is just a bunch of millilitres put all together. In fact, 1000 millilitres makes up 1 litre: 1 litre = 1,000 millilitres

G2.22 Convert metric units of volume or capacity (litres only) Convert: 5000ml to L 7L to ml 700ml to L	**1000ml** | **1L** e.g. convert: 5000ml to L Divide by 1000 =5L 7L to ml Multiply by 1000 = 7000ml 700ml to L Divide by 1000 =0.7L To work the other way i.e. L to ml you do the inverse i.e. multiply by 1000

G2: 2D Shapes

Use simple conversions of imperial to metric

Enlarge a shape by an integer factor with a centre of enlargement

G2.23

Use simple conversions of imperial to metric

- **Imperial units**

Length	Weight	Capacity
1 inch=2.5cm	2.2 pounds≈1kg	1gallon≈4.5litres
1 foot=30cm		
1 mile≈1.6km		

Convert:

3 inches to cm

Multiply by 2.5 =7.5cm

5 feet to cm

Multiply by 30 = 150cm

4 miles to km

Multiply by 1.6 ≈ 6.4km

180 pounds to kg

Divide by 2.2 ≈ 82kg

7 gallons to litres

Multiply by 4.5 ≈31.5L

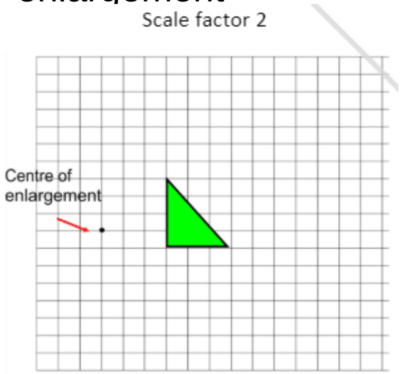
To work the other way i.e. cm to feet you do the inverse i.e. divide by 30

G2.24

Enlarge a shape by an integer scale factor with a centre of enlargement

e.g.

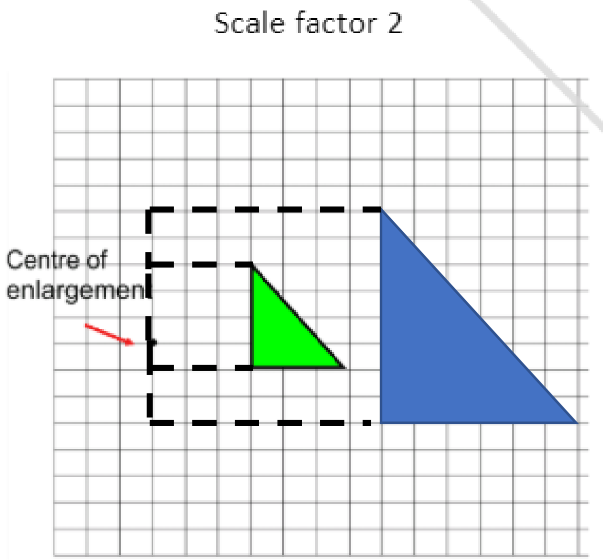
Enlarge the following shape by the given scale factor and from the given centre of enlargement



You sometimes can be asked to enlarge from a specific **centre of enlargement.** When a shape is **enlarged** from a **centre of enlargement**, the distances from the **centre** to each point are multiplied by the scale factor.

e.g. Enlarge the following shape by the given scale factor and from the given centre of enlargement

To enlarge using a centre of enlargement, you count the distance from of each point from the centre of enlargement, then multiply that distance by the scale factor.



G2: 2D Shapes

Describe an enlargement by an integer scale factor and a centre of enlargement

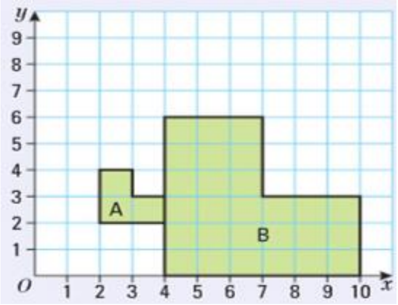
Enlarge a shape using a fractional scale factor

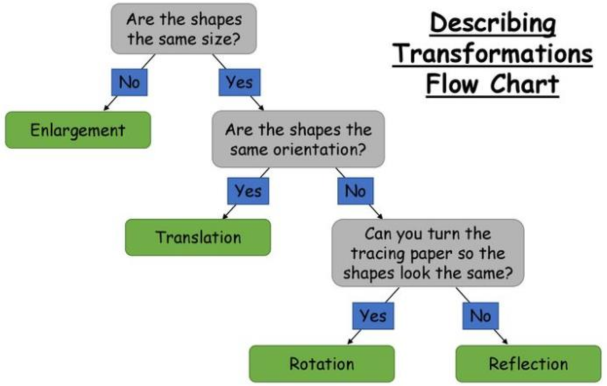
G2.25

Describe an enlargement by an integer scale factor and a centre of enlargement

e.g.

Describe fully the single transformation that maps A onto B

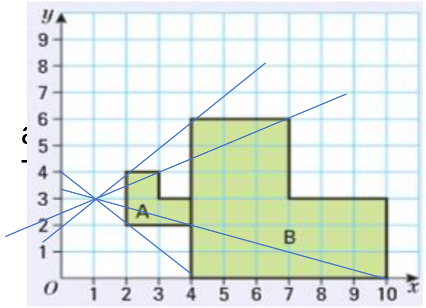




First of all use the flow chart to decide which of the transformations it is.

When you have found that it is an enlargement, you need to find the scale factor. To do this you must count the length of the sides and see what you multiply by to get from A to B.

To work out the centre of enlargement you join the vertices of both shapes and see where the lines intersect, this is the centre of enlargement.



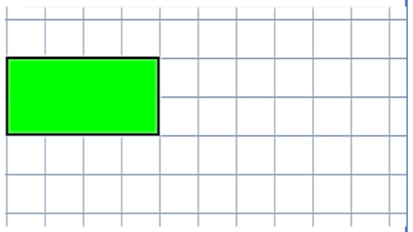
This is an enlargement, with scale factor of 3. centre of enlargement is (1,3)

G2.26

Enlarge a shape using a fractional scale factor

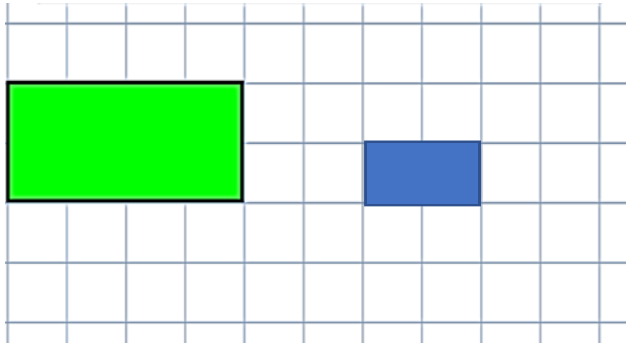
e.g.

Enlarge the following shape with a scale factor of a $\frac{1}{2}$



To enlarge a shape with a fractional scale factor, you follow the same steps as when you enlarge with an integer.

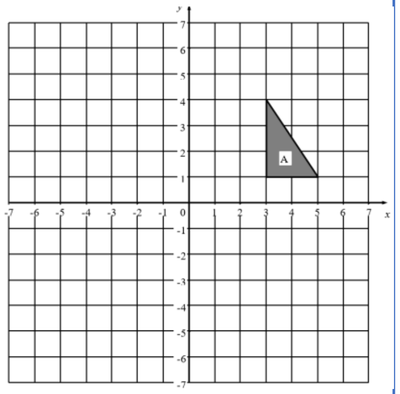
e.g. enlarge the following shape with a scale factor of a $\frac{1}{2}$.



G2.27

Translate a shape

e.g. Translate the following shape in the vector $\begin{bmatrix}2\\1\end{bmatrix}$



A **translation** moves a shape up, down or from side to side but it does not change its appearance in any other way.

Translation is an example of a **transformation**. A transformation is a way of changing the size or position of a shape.

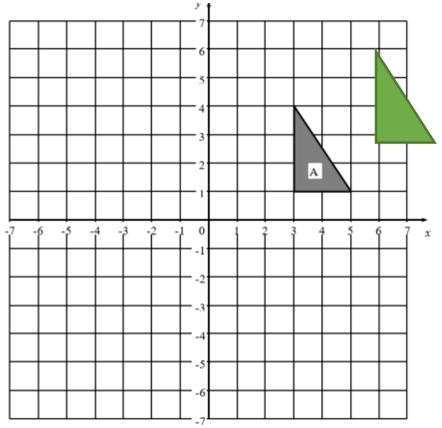
Every point in the shape is translated the same distance in the same direction.

Column **vectors** are used to describe translations.

$\begin{bmatrix}4\\-2\end{bmatrix}$ Means that you move the shape 4 to the right and 2 down

$\begin{bmatrix}-2\\5\end{bmatrix}$ Means that you move the shape 2 to the left and 5 up

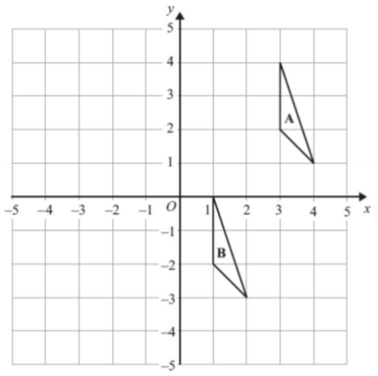
e.g. Translate the following shape in the vector $\begin{bmatrix}2\\1\end{bmatrix}$

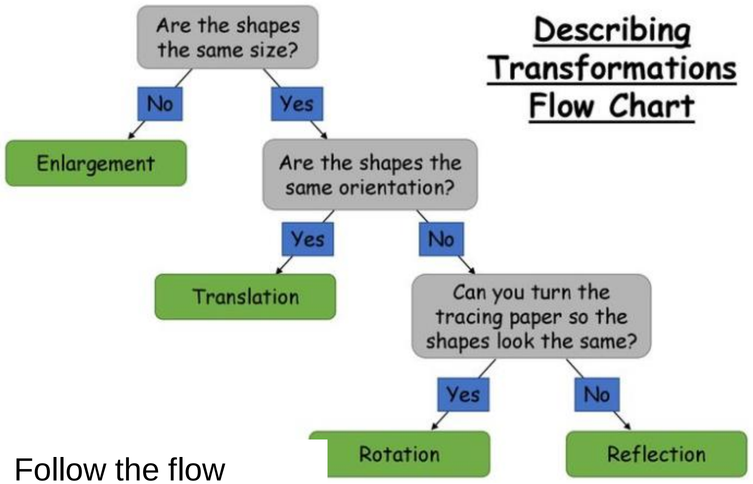


G2.28

Describe a Translation

Describe the transformation that fully maps A onto B



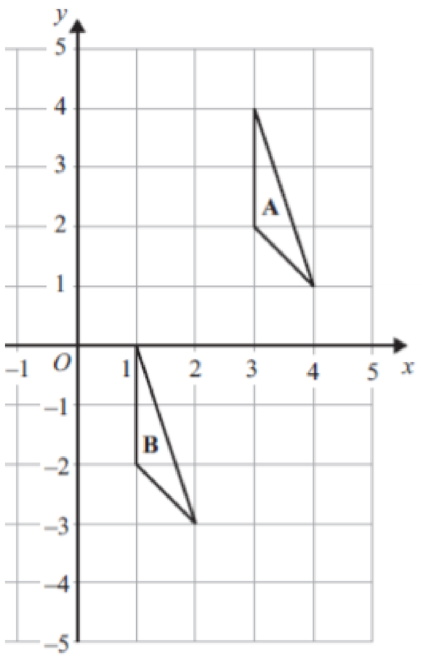


Follow the flow diagram to see which of the transformations it is.

Translation

Find the vector by counting the squares. This shape has moved 2 left and 4 down. So the vector is $\begin{bmatrix}-2\\-4\end{bmatrix}$

So the single transformation is **a translation in the vector** $\begin{bmatrix}-2\\-4\end{bmatrix}$



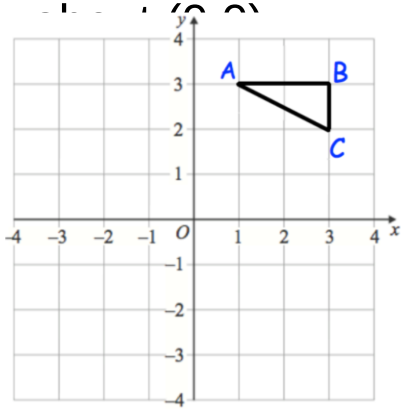
G2: 2D Shapes

Rotate a shape with a given centre of rotation
Describe a rotation through a centre of rotation

G2.29

Rotate a shape with a given centre of rotation

e.g. Rotate the following shape 90° clockwise about (0,0)



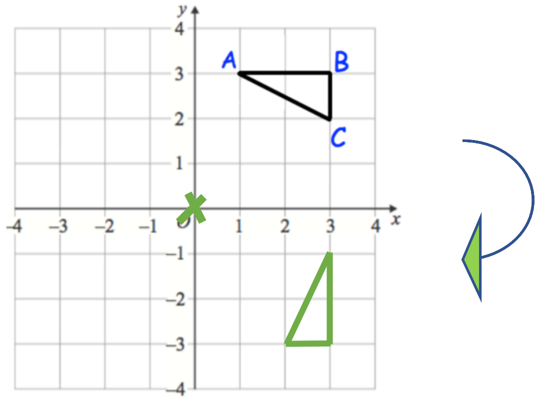
Rotation turns a shape around a fixed point called the **centre of rotation**.

Rotation is an example of a **transformation**. A transformation is a way of changing the size or position of a shape.

Three pieces of information are needed to rotate a shape:

- the centre of rotation
- the angle of rotation
- the direction of rotation

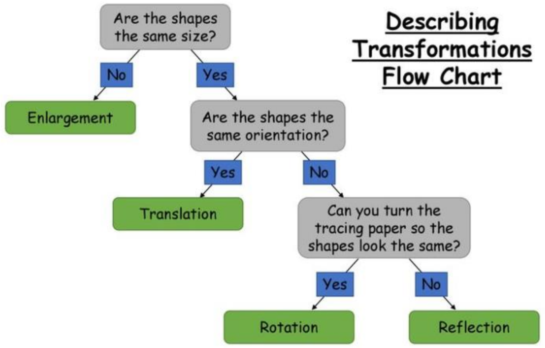
e.g. Rotate the following shape 90° clockwise about (0,0)



In this particular question you rotate the shape a quarter turn clockwise (using tracing paper) with your pencil on the given coordinate.

G2.30

Describe a rotation through a centre of rotation



First of all decide which of the transformations it is by using the flow chart.

Find two corresponding points on the original shape and the shape that's been rotated — typically, the pointy end of the triangle, or a convenient right angle. Draw a line between them.
At each of the points, draw a line at 45º towards where you thing the centre of rotation ought to be.
Where these lines cross is the centre of rotation.
Check you've gone the right way: measure the distance from your centre to two other corresponding points and check they're the same.
Otherwise, you need to draw your 45º lines on the other side of your line
Continued on the next page.

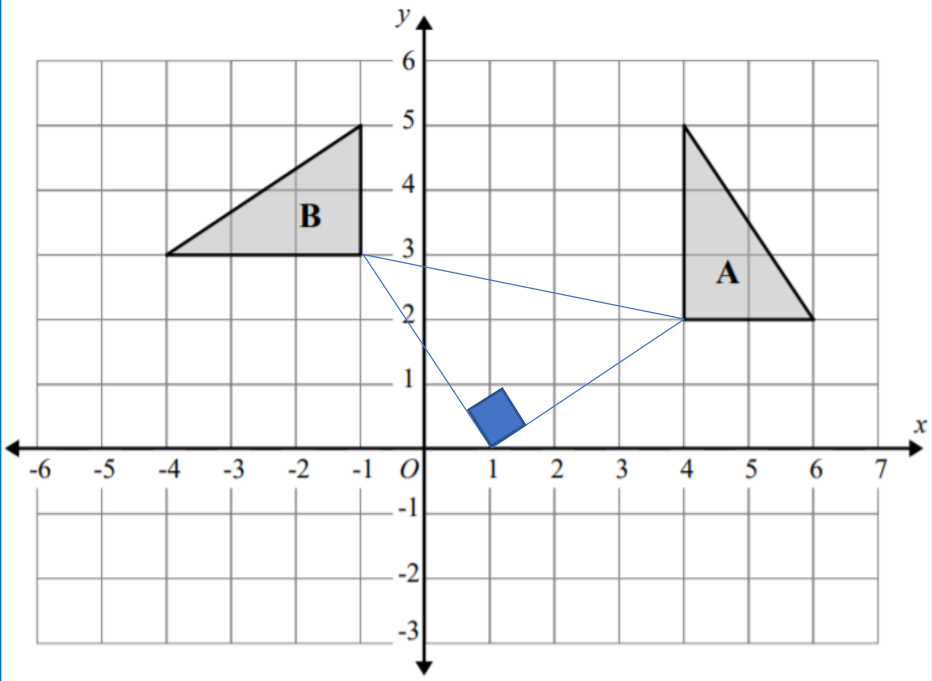
G2: 2D Shapes

Describe a rotation through a centre of rotation (continued)

Reflect a shape using a diagonal or horizontal line

G2.30

Continued



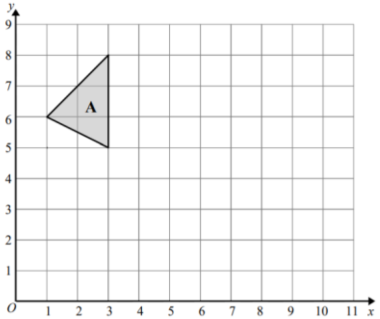
This is a rotation, 90° anticlockwise, from (1,0)

G2.31

Reflect a shape using a diagonal line or horizontal line

e.g.

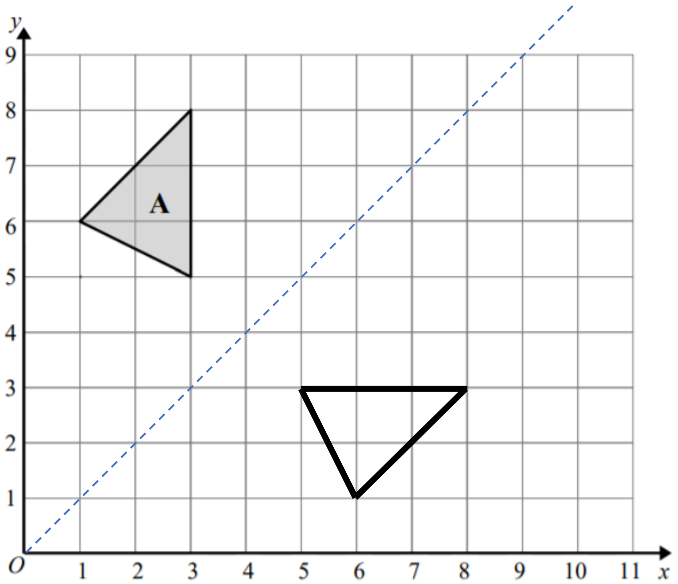
Reflect the following shape in the line y = x



Firstly, you must find the mirror line. In the line y = x the y coordinate is the same as the x coordinate.

This means if you y coordinate is 1 your x coordinate is 1. This creates a diagonal line from the origin.

You then count the distance from each vertex to the mirror line and replicate it on the other side of the mirror line.



G2: 2D Shapes

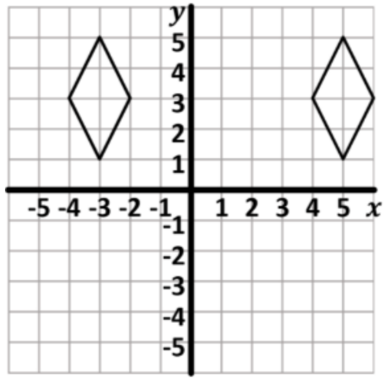
Describe a reflection using the equation of a line
Calculate the area of a trapezium

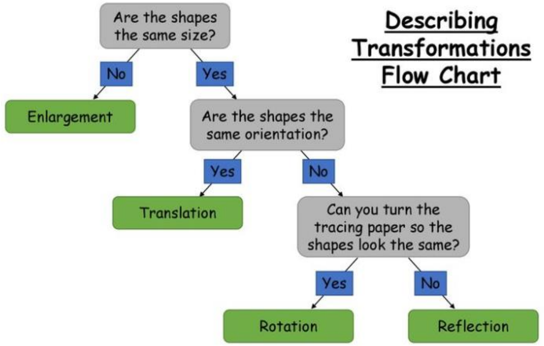
G2.32

Describe a reflection using the equation of a line

e.g.

Describe the single transformation that maps shape A to B.

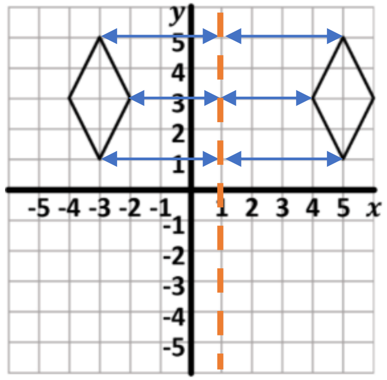




Firstly you need to decide which of the transformations it is.

When you have found that it is a reflection , you need to find the mirror line.

To do this you need to find a line in which all the points of each shape will be equidistant to the corresponding point.



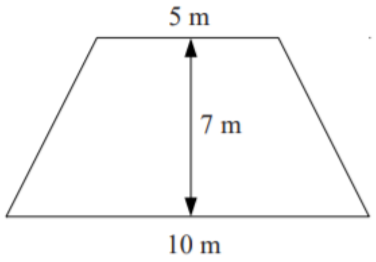
So this is a reflection in the line x=1

G2.33

Calculate the area of a trapezium

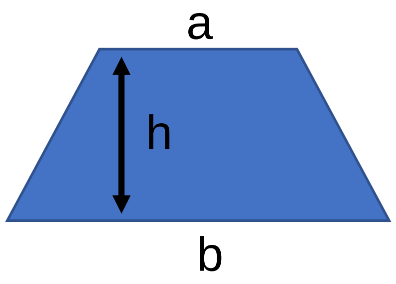
e.g.

Calculate the area of the following shape

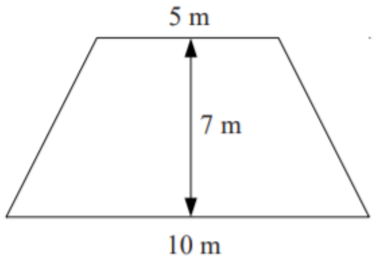


To find the area of a trapezium you need to use a specific formula.

$$A = \frac{(a+b)}{2} \times h$$



e.g. Calculate the area of the following shape



Area = $\frac{(5+10)}{2}$ x 7

Area = $\frac{15}{2}$ x 7

Area = 7.5 x7

Area = 52.5 m^2

G2: 2D Shapes
Calculate the area of a circle
Calculate the circumference of a circle

G2.34

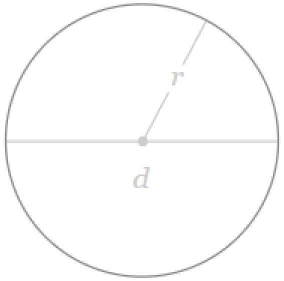
Calculate the area of a circle

e.g.

Work out the area of the following circle

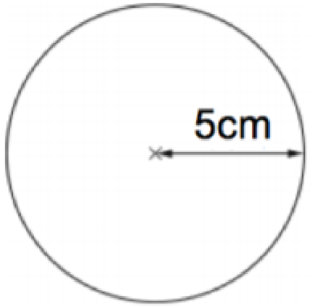
To find the area of a circle you need to follow a specific formula.

$$A = \pi r^2$$



e.g. work out the area of the following circle

Area $= \pi r^2$
Area = π x 5^2
Area = 78.5398163…
Area = 78.5 cm^2 1dp

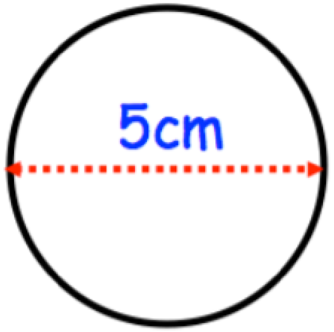


G2.35

Calculate the circumference of a circle

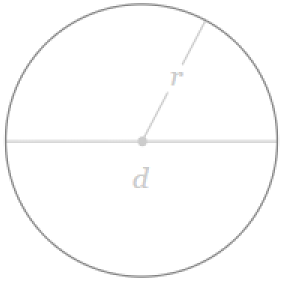
e.g.

Work out the circumference of the following circle



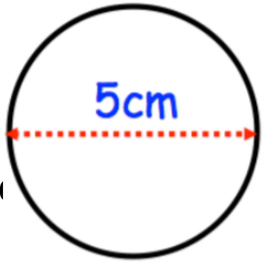
To find the circumference of a circle you need to follow a specific formula.

$C = 2\pi r$ or $c = \pi d$



e.g. Work out the circumference of the following circle

Circumference = πd
Circumference = π x 5
Circumference = 15.707…
Circumference = 15.7cm 1



G2: 2D Shapes

Calculate the area of a sector

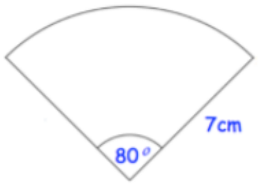
Calculate arc length

G2.36

Calculate the area of a sector

e.g.

Find the area of the following sector

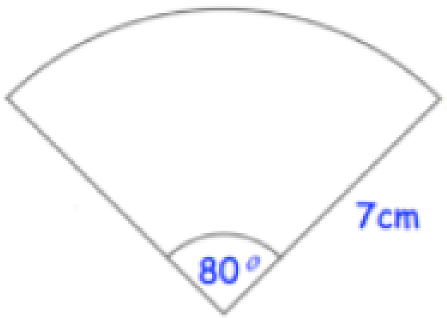


We can find the area of a sector using the formula:

$$\frac{\theta}{360} \times \pi r^2$$

θ is the angle of the secto r is the radius

e.g. Find the area of the following sector



Area = $\frac{80}{360}$ x π x 7^2

Area = 34.208…

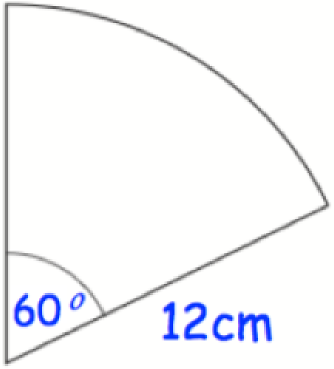
Area = 34.2cm² 1dp

G2.37

Calculate arc length

e.g.

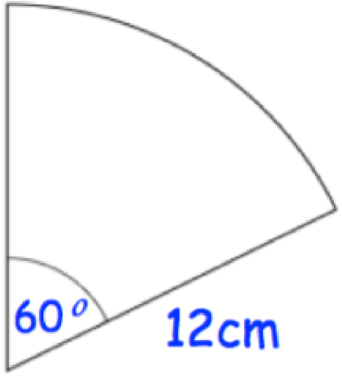
Evaluate the length of the following arc



To *calculate arc length you use*

$$\textit{Arc length} = \frac{angle}{360^\circ} \times \pi \times d$$

e.g. Find the length of the following arc



Arc length = $\frac{60}{360}$ x π x 24

Arc length = 12.566…

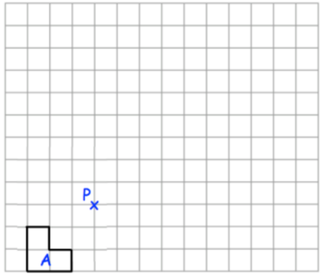
Arc length = 12.6 cm

G2: 2D Shapes
Enlarge a shape using a negative scale factor
Convert metric units of area and volume

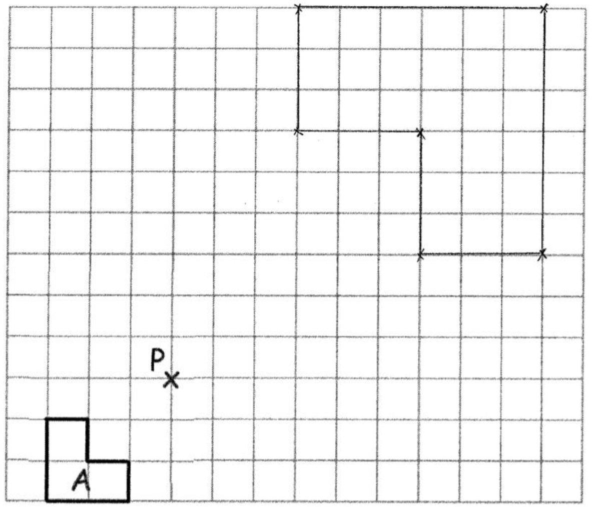
G2.38

Enlarge a shape using a negative scale factor

e.g. Enlarge the following shape with a scale factor of -3 from point 3



An **enlargement** using a **negative scale factor** will cause the **enlargement** to appear on the other side of the centre of **enlargement**; and will be inverted (upside down). The **shape** will also change size depending on the value of the **enlargement**.



To enlarge by a negative scale factor, you need to work out the vector from P to each corner of the shape.

You then multiply each vector by the scale factor.

You will end up with new vectors that you draw from p.

In this example you multiply each vector by -3.

G2.39

Convert metric units of area or volume

e.g. Convert $5m^2$ to cm^2

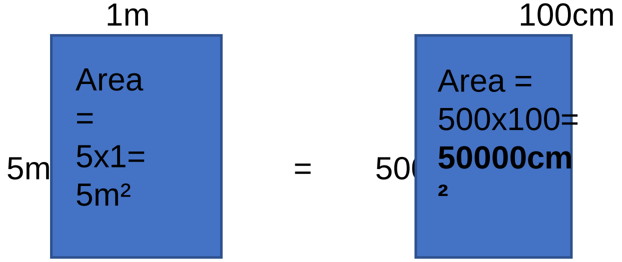
e.g. Convert 5,000 mm^3 to cm^3

The method for converting between units works the same as the one for converting units of area and volume.

When you are converting one sort of unit to another, you need to know how many smaller units are needed to make 1 larger unit.

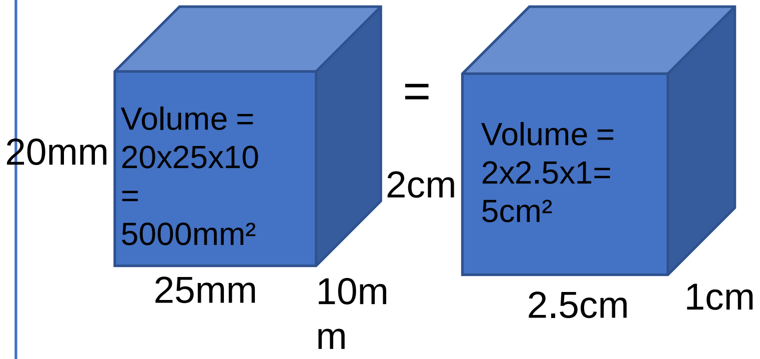
Area

Convert $5m^2$ to cm^2



Volume

Convert 5,000 mm ^{3} to cm ^{3}

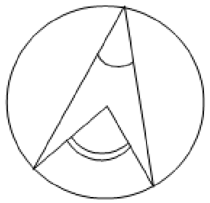


G2: 2D Shapes
Recognise the circle theorems

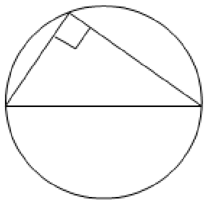
G2.40

Recognise the circle theorems

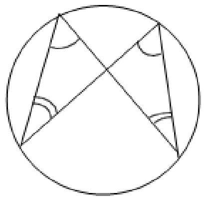
e.g. What are the eight circle theorems?



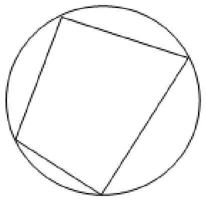
The angle at the centre = 2 x angle at the circumference



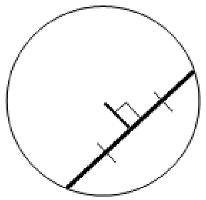
The angle in a semi-circle is a right angle



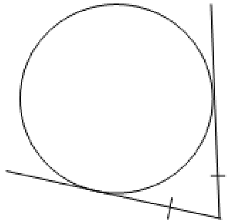
Angles in the same segment are equal



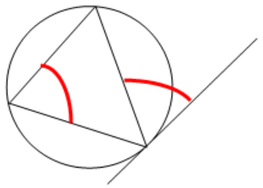
Opposite angles in a cyclic quadrilateral add up to 180º



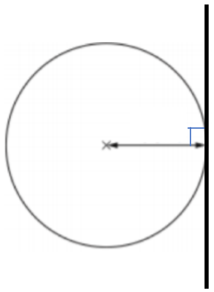
The perpendicular from the centre to the chord bisects the chord



Tangents from a point to a circle are equal



The angle between a tangent and a chord is equal to the angle in the alternate segment

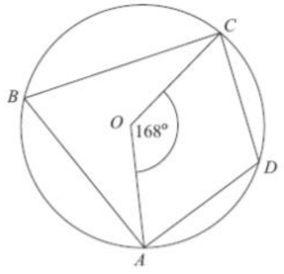


The angle between a tangent and a radius is always 90º

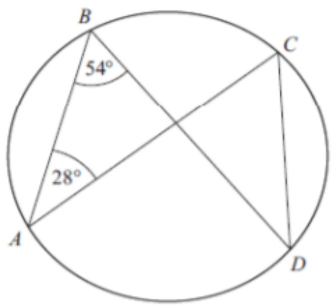
G2: 2D Shapes
Use circle theorems to solve problems

G2.41

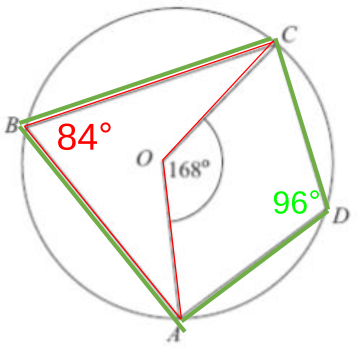
Use circle theorems to solve problems



e.g. Work out angle ADC

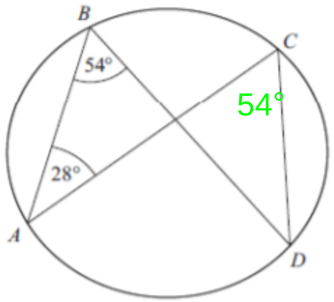


e.g. Work out the angle ACD, give reasons for your answer



Work out angle ADC

Angle ABC = 84° Angle at the centre is 2x the angle at the circumference.
Angle ADC = 96° Opposite angles in a cyclic quadrilateral add up to 180°



Work out the angle ACD, give reasons for your answer

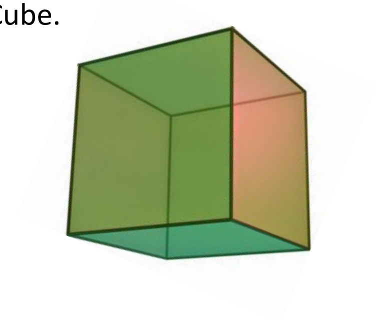
ACD = 54° because angles in the same segment are equal.

G3: 3D Shapes

Identify properties of a 3D shape
Represent a 3D shape on an isometric grid
Identify a net of a cube
Identify a net of other 3D cuboids

G3.1
Identify properties of a 3D shape

E.g. Name the properties of a Cube.



3D shapes have faces (sides), edges and vertices (corners).

Faces
A face is a flat or curved surface on a 3D shape. E.g. a cube has 6 faces, a cylinder has 3 and a sphere 1.

Edges
An edge is where two faces meet. E.g. a cube has 12 edges, a cylinder has 2 and a sphere has none.

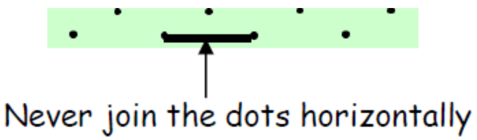
Vertices
A vertex is a corner where edges meet. The plural is vertices. E.g. a cube has 8 vertices, a cone has 1 vertex and a sphere has none.

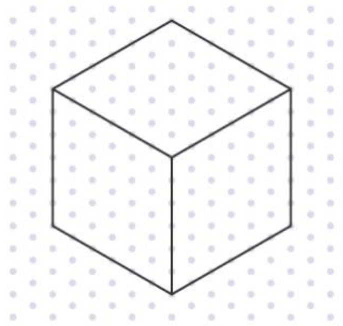
A cube has 6 identical faces, 12 edges and 4 vertices.

G3.2
Represent a 3D shape on an isometric grid

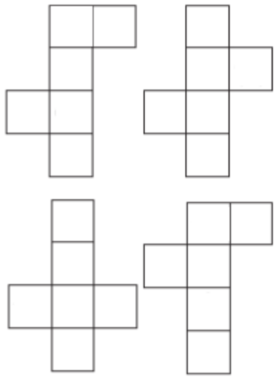
E.g. Create an isometric drawing of a cube measuring 6cm x 6cm x 6cm.

Isometric paper is used to accurately draw 3D shapes.

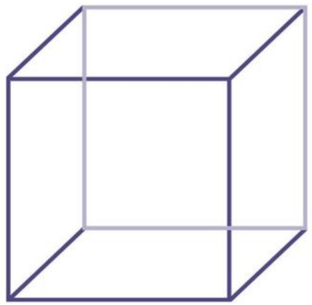




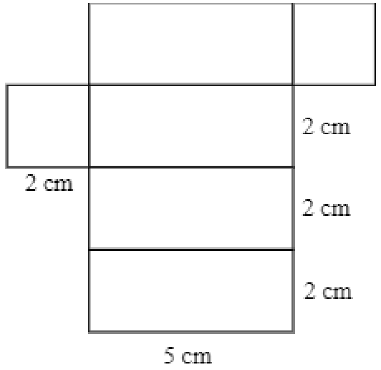
G3.3
Identify a net of a cube.
E.g. What 3D shape do all of these nets form?



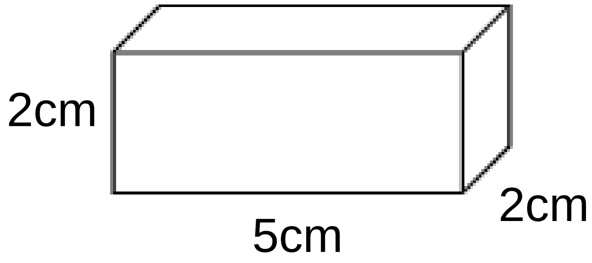
A cube



G3.4
Identify a net of other 3D cuboids.
E.g. Draw and name the shape this would create and include the measurements.



A cuboid.

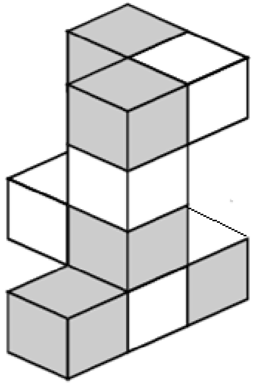


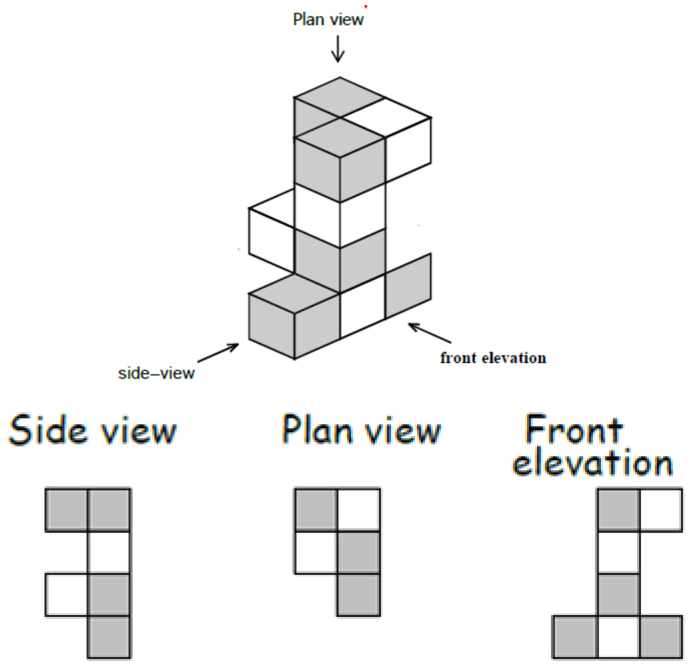
G3: 3D Shapes

Identify a 3D shape from plans and elevations
Calculate the volume of a cuboid
Calculate the surface area of a cuboid
Recognise the net of a cylinder

G3.5
Interpret a 3D shape from plans and elevations

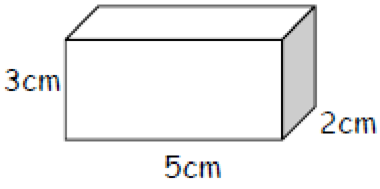
E.g. Draw the Side view, Plan View and Front Elevation of this shape.





G3.6
Calculate the volume of a cuboid

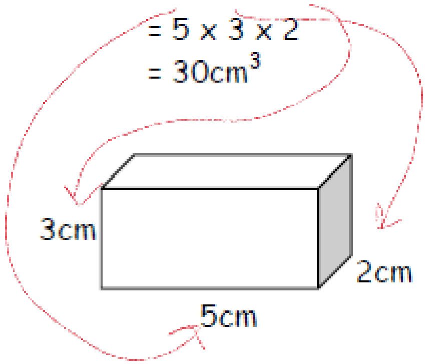
E.g. Calculate the volume of this cuboid.



Volume is the amount of space a 3D shape takes up.

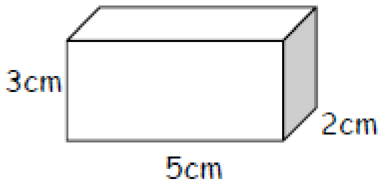
- Volume of cuboid

Volume = l x w x h
= 5 x 3 x 2
= $30cm^3$



G3.7
Calculate the surface area of a cuboid

E.g. Calculate the surface area of this cuboid.



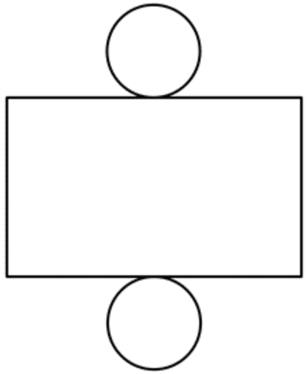
Surface area is the amount of space covering the outside of a three-dimensional shape
Remember a cuboid has 6 faces, you need to include all 6.

- Surface area of cuboid

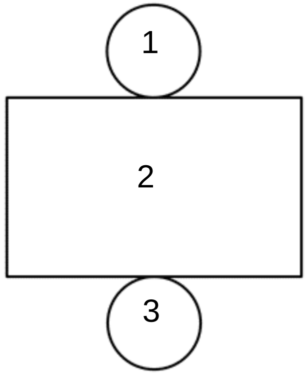
Front = 5x3 = 15
Back = 5x3 = 15
Top = 5x2 = 10
Bottom = 5x2 = 10
Side = 3x2 = 6
Side = 3x2 = 6

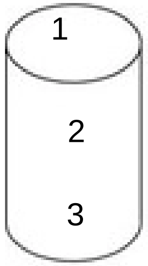
Total Surface Area = $62cm^2$

G3.8
Recognise the net of a cylinder
E.g. What 3D shape does this net form?



A cylinder.



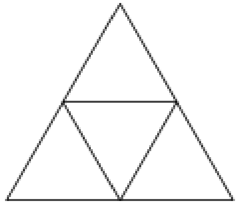


G3: 3D Shapes

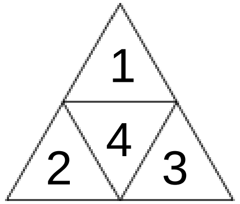
Recognise the net of a tetrahedron
Recognise the net of prisms
Calculate the volume of a prism
Calculate the volume of a prism

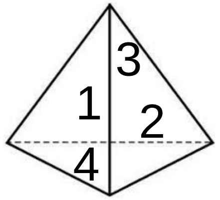
G3.9
Recognise the net of a tetrahedron

E.g. What 3D shape does this net create?



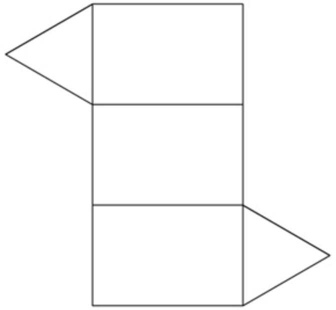
A Tetrahedron. also known as a triangular pyramid, is a polyhedron composed of four triangular faces, six straight edges, and four vertex corners.



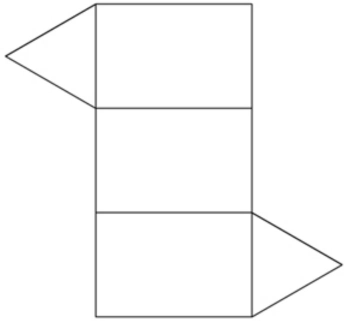


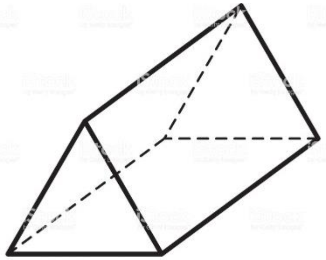
G3.10
Recognise the net of prisms

E.g. What 3D Shape would this net form?



A Triangular Prism. A triangular prism is a prism composed of two triangular bases and three rectangular sides.





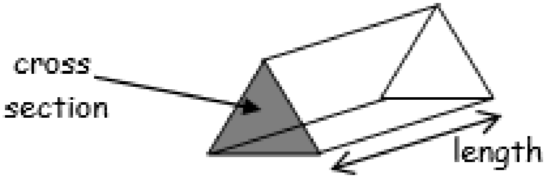
G3.11
Calculate the volume of a prism

E.g. What is the formula for working out the volume of any prism?

To find the volume of any prism, calculate the area of the cross-section and multiply by the length.

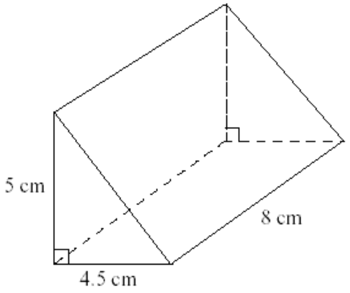
Volume = Area of cross-section x length

With any prism there is a shape which is repeated throughout the length - this is the cross section.

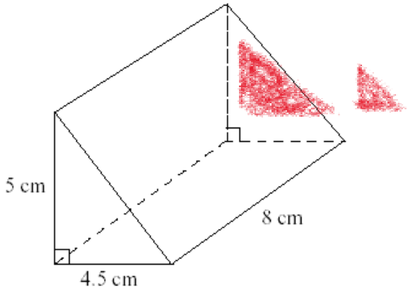


G3.12
Calculate the volume of a prism

E.g. Calculate the volume of this Triangular Prism



Volume = Area of cross-section x length



Area of cross section

$= \frac{5 \times 4.5}{2} = 11.25\text{cm}^2$

Volume =
$11.25 \times 8 = 90\text{cm}^3$

G3: 3D Shapes

Calculate missing sides from volume

Calculate the surface area of a cylinder

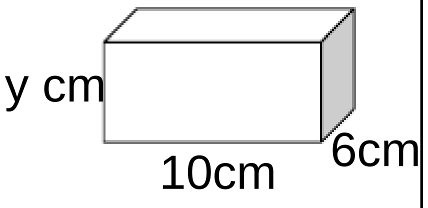
Use the formula for volume of a sphere

Use the formula for the volume of a cone

G3.13

Calculate missing sides from volumes

E.g. The volume of this cube is 420cm³. What is the length the missing side?



Volume of a cuboid = Length x Height x Width

420 = 10 x 6 x y

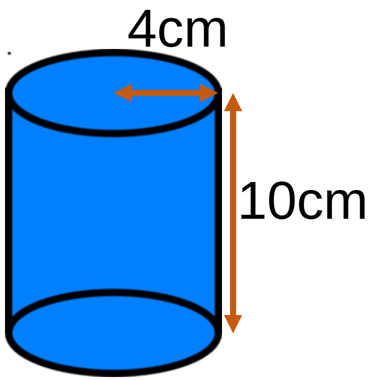
420 = 60y

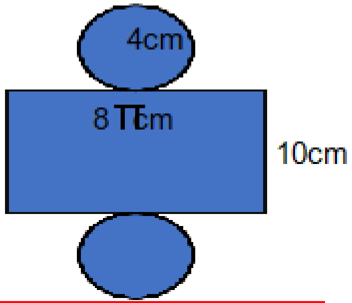
Y = 7cm

G3.14

Calculate the surface area of a cylinder

E.g. Calculate the surface area of this cylinder.





Circle = $4^2 \times \pi$

2 x Circle = 32π

Rectangle = $8\pi \times 10$

= 80π

Length of the rectangle = the circumference of the circle.

C= πd

= 8π

Total Surface area

= $32\pi + 80\pi$

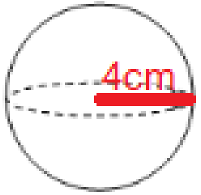
= $112\pi cm^2$

($351.86cm^2$)

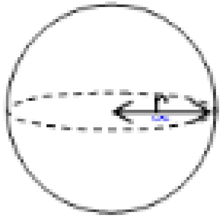
G3.15

Use the formula for volume of a sphere

E.g. Calculate the volume of this sphere to one decimal place.



Volume of sphere = $\frac{4}{3}\pi r^3$



$= \frac{4}{3} \times \pi \times 4^3$

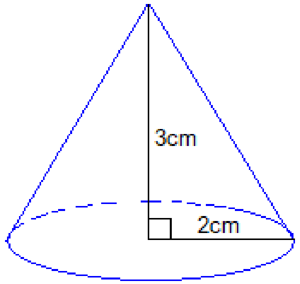
$= \frac{4}{3} \times \pi \times 4^3$

$\frac{256\pi}{3} = 85.3cm^3$

G3.16

Use the formula for the volume of a cone

E.g. Calculate the volume of this cone to one decimal place.



Volume = $\frac{1}{3}\pi r^2 h$

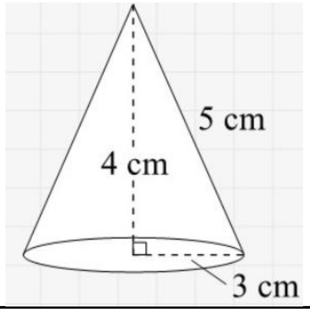
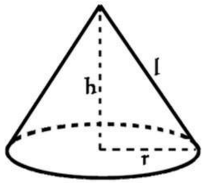
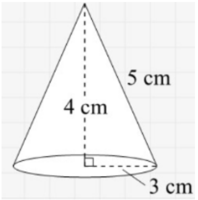
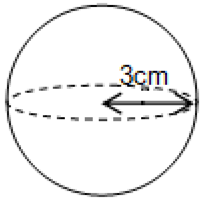
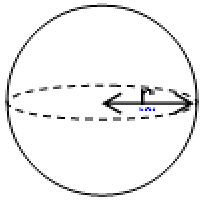
$v = \frac{1}{3} \times \Pi \times 2^2 \times 3$

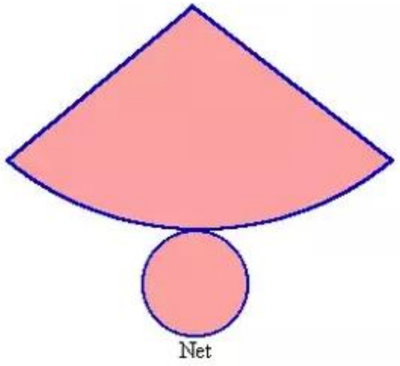
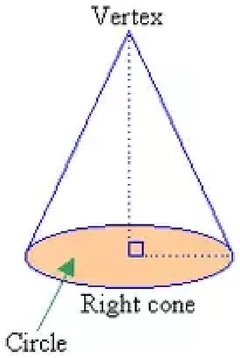
$v = 4\Pi$

$v = 12.6cm^3$

G3: 3D Shapes

Use the formula for curved surface area of a cone
Use the formula to find the surface area of a sphere
Recognise the net of a cone

G3.17 Use the formula for curved surface area of a cone E.g. Work out the area of the curved surface of this cone. Leave in terms of pi. 	The area of the curved (lateral) surface of a cone $= \pi r l$ Where, *r* is the radius *h* is the height *l* is the slant height   $SA = \pi r l$ $= \pi \times 3 \times 5$ $= 15\pi$
G3.18 Use the formula to find the surface area of a sphere E.g. Calculate the surface area of this sphere. Leave your answer in terms of pi. 	Curved surface area of a sphere $= 4\pi r^2$  $SA = 4\pi r^2$ $= 4 \times \pi \times 3^2$ $= 4 \times \pi \times 9$ $= 36\pi$

G3.19 Recognise the net of a cone E.g. What 3D shape does this net create? 	 A Cone. The **net** of a cone consists of the following two parts: • a circle that gives the base; and • a sector that gives the curved surface

G3: 3D Shapes

Calculate the volume of a frustum

Calculate the curved surface area of a frustum

G3.20

Calculate the volume of a frustum

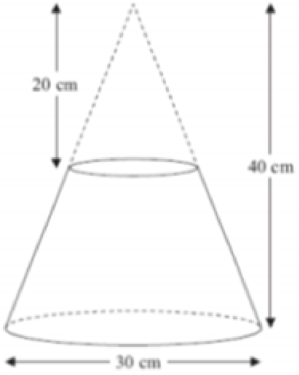
E.g. Below is the frustum of a cone.

The height of the small cone is 20cm.

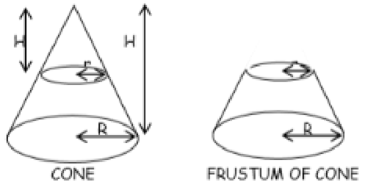
The height of the large cone is 40cm.

The diameter of the base of the large cone is 30cm.

Work out the volume of the frustum. Leave your answer correct to 3.s.f.



A frustum is a cone that has had a smaller cone removed from the top.



Volume of a Cone = $\frac{\pi r}{3}$

Radius is half of diameter

Large cone = $\frac{\pi 15^2 \times 40}{3}$

= 3000π

To find the radius of the small cone we have to remember it is in proportion. The height goes from 40cm to 20cm ..It has halved.

So we can half the radius too.

Small cone = $\frac{\pi 7.5^2 \times 20}{3}$

= 375π

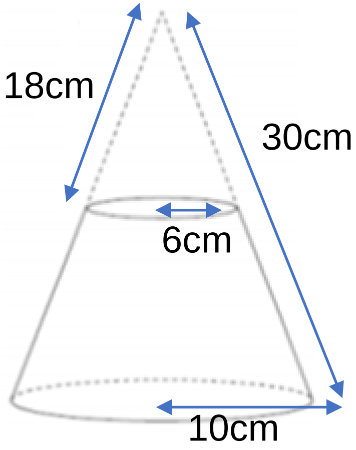
Large cone - small cone = $2625\,\pi$

= 8250cm^3

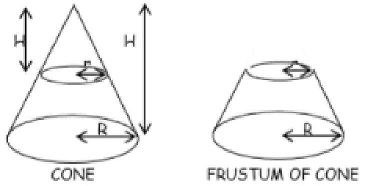
G3.21

Calculate the curved surface area of a frustum

E.g. Work out the curved surface area of the frustum of the cone below. Leave your answer in terms of pi.



A frustum is a cone that has had a smaller cone removed from the top.



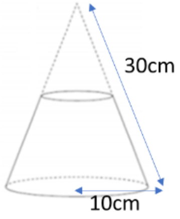
So we want to find the curved surface area of the large cone and take away the curved surface area of the small cone.

Curved surface area of a cone = πrl

Where l is the slanted height of the cone.

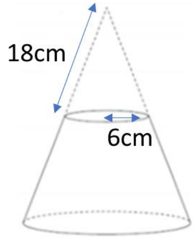
Large cone = $\pi \times 10 \times 30$

= 300π



Small cone = $\pi \times 6 \times 18$

= 108π



Total surface area of the frustum

= large cone - small cone

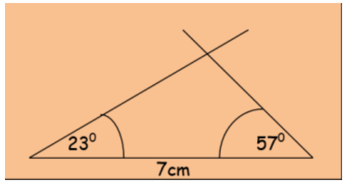
$300\pi - 108\pi = 192\pi$

G4: Constructions and Loci

Construct a triangle given two angles and a side
Construct a triangle given two sides and an angle
Construct a triangle given all three sides
Construct a right angled triangle given the hypotenuse

G4.1 Construct a triangle given two angles and a side (ASA)

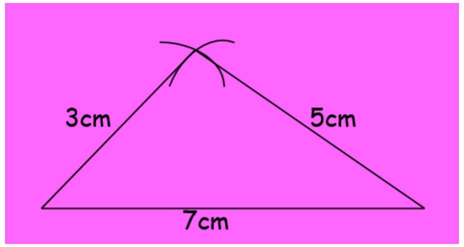
Measure out the base using a ruler
Use a protractor to construct the angles
Leave construction lines



G4.2 Construct a triangle given two sides and an angle (SAS)

Draw the base using a ruler
Use a protractor and draw in the angle
Measure second side using a ruler and draw it in.
Complete the triangle

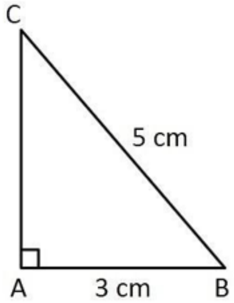
G4.3 Construct a triangle given all three sides (SSS)



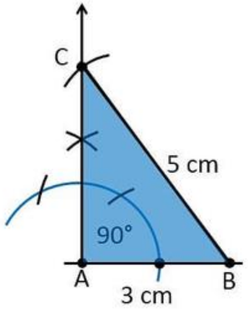
Use a compass and leave the arcs.

G4.4 Construct a right angled triangle given the hypotenuse

Example:



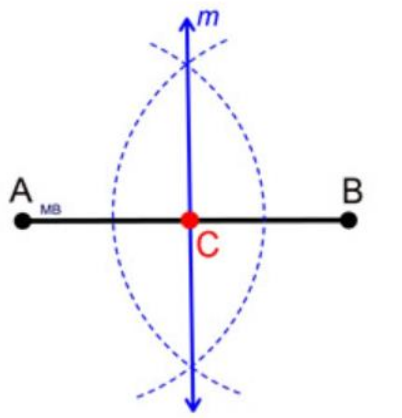
Draw line segment of 3cm to form the base
Construct a perpendicular bisector from A
Using a compass construct an arc from B, crossing the perpendicular bisector at C
Draw in the sides of your triangle, leaving the construction marks.

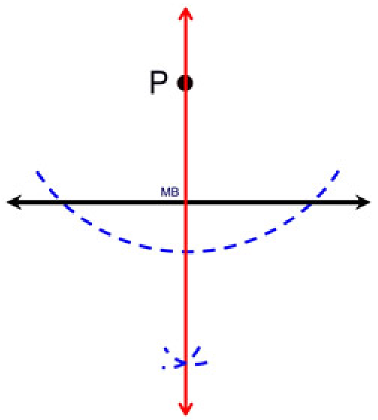


G4: Constructions and Loci

Construct a perpendicular bisector

Construct a perpendicular bisector from a point to a line

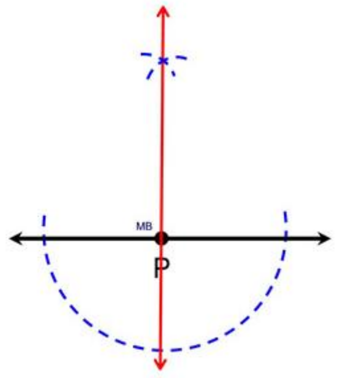
G4.5 Construct a perpendicular bisector	Using a compass construct arcs from points A & B. Make sure the distance between your pencil and the compass point is the same for both. Complete your bisection by drawing a line through the intersecting points of the two arcs, going through C on the diagram 

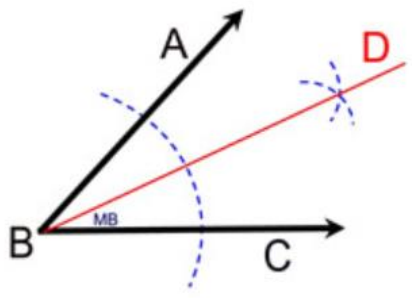
G4.6 Construct a perpendicular bisector from a point to a line segment	Using a compass construct a semicircle below the line segment, placing your compass point at P. Construct a perpendicular as you did before, using the points where the semicircle crosses the line segment as point A & B as in the example given in G4.5 

G4: Constructions and Loci

Construct a perpendicular bisector through a point on a line segment

Construct an angle bisector

G4.7 Construct a perpendicular bisector through a point on a line segment	Using a compass construct a semicircle below the line segment, placing your compass point at P. Construct a perpendicular as you did before, using the points where the semicircle crosses the line segment as point A & B as in the example given in G4.5 

G4.8 Construct an angle bisector	Using a compass construct an arc from B, passing through both AB and BC. Draw an arc, placing the compass point at the intersection on AB. Repeat for the intersection on BC. The arcs with intersect at D. Draw a line segment through D to B as shown in the diagram. 

G4: Constructions and Loci

Draw a locus of points a given distance from a point (circle)

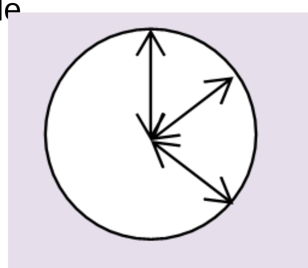
Draw a locus of points equidistant from two points

Draw a locus of points equidistant from two lines

G4.9 Draw a locus of points a given distance from a point (circle)

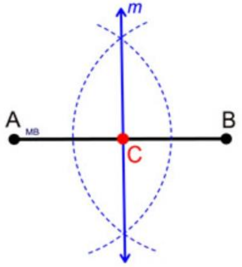
A **locus** is the path or region a point covers as it moves according to a rule.

A series of points a fixed distance (equidistant) from a point is a circle.



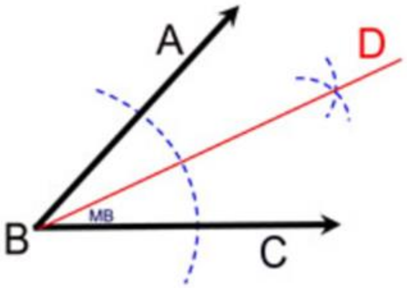
G4.10 Draw a locus of points equidistant from two points

The locus of points equidistant from two points is a perpendicular bisector (see G4.5, G4.6, G4.7)



G4.11 Draw a locus of points equidistant from two lines

The locus of points equidistant from two intersecting lines is an angle bisector (see G4.8)

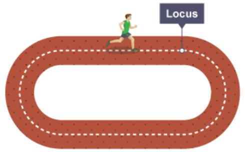


G4: Constructions and Loci

Apply loci techniques to more complex problems

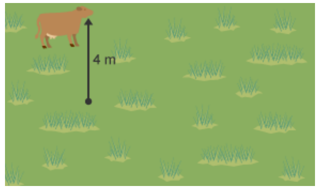
G4.12 Apply loci techniques to more complex loci problems

Some **examples** of more complex loci problems.
Remember that loci is the plural of locus.
The runner is following a path.
The path is a locus.



The hands of a clock move around the clock and create a locus.

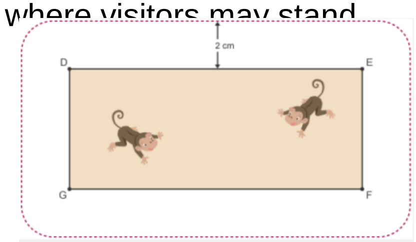
A cow is tied to a post by a 4m length of rope. The area of grass she can reach is a locus.



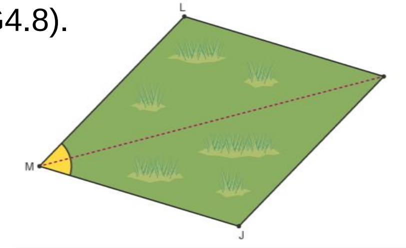
G4.12 Apply loci techniques to more complex loci problems

Some **examples** of more complex loci problems.
Remember that loci is the plural of locus.

Visitors must stand 2m away from the walls of a monkey enclosure. The diagram shows where visitors may stand.



The path is equidistant between the edges of the field, MJ and ML.
The locus is an angle bisector (G4.8).



G5: Pythagoras and Trigonometry

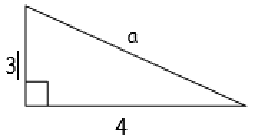
Use Pythagoras' theorem to find a missing side

Use Pythagoras' theorem to calculate a missing side

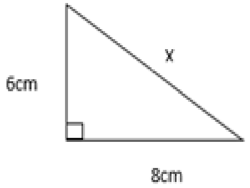
G5.1 Use Pythagoras' theorem to find a missing hypotenuse

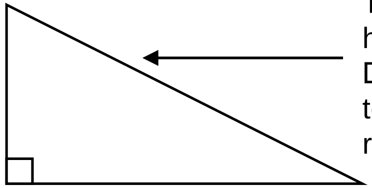
e.g

Find a in the triangle below



e.g
Find x in the triangle below





The hypotenuse DOESN'T touch the right angle

If you are finding the hypotenuse, square the two shorter sides, add them together and square root the number you get

e.g

$$3^2 + 4^2 = a^2$$
$$9 + 16 = a^2$$
$$\sqrt{25} = a$$
$$5 = a$$

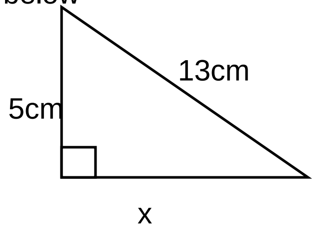
e.g

$$6^2 + 8^2 = x^2$$
$$36 + 100 = x^2$$
$$\sqrt{136} = x$$
$$11.7 = x$$

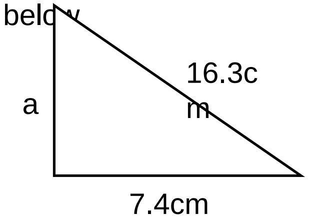
G5.2 Use Pythagoras' theorem to calculate a missing side

e.g

Find x in the triangle below



e.g
Find a in the triangle below



If you are finding one of the two shorter sides (not the hypotenuse), square the two sides you have, subtract the shorter from the longer and square root the answer

e.g

$$5^2 + x^2 = 13^2$$
$$x^2 = 13^2 - 5^2$$
$$x^2 = 169 - 25$$
$$x = \sqrt{144}$$
$$x = 12$$

e.g

$$7.4^2 + a^2 = 16.3^2$$
$$a^2 = 16.3^2 - 7.4^2$$
$$a^2 = 265.69 - 54.76$$
$$a = \sqrt{210.93}$$
$$a = 14.5 \quad 1dp$$

G5: Pythagoras and Trigonometry

Use trigonometry for right angle triangles to find a missing side

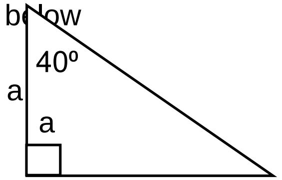
Use trigonometry for right angle triangles to find missing angles

Use vector column notation

G5.3 Use Trigonometry for right angled triangles to find a missing side

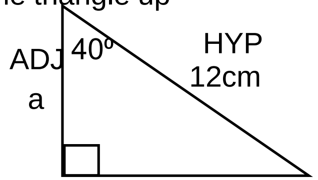
e.g

Find a in the triangle below



Remember SOHCAHTOA.
Label the sides of the triangle you have with Opposite, Adjacent or Hypotenuse. Choose the correct trigonometric ratio to use. Substitute into the relevant formula and solve the equation

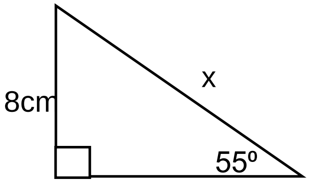
e.g
Label the triangle up



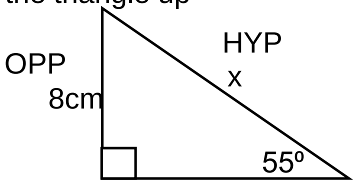
We have adj and hyp so use Cosine

$$\cos(40) = \frac{a}{12}$$
$$12 \times \cos(40) = a$$
$$9.19cm = a$$

e.g
Find x in the triangle below



e.g
Label the triangle up

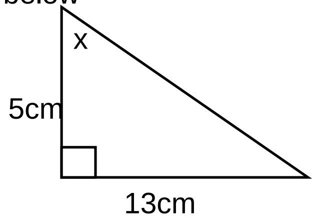


We have opp and hyp so use Sine

$$\sin(55) = \frac{8}{x}$$
$$x = \frac{8}{\sin(55)}$$
$$x = 9.77cm$$

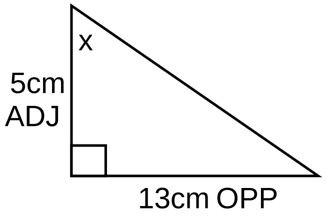
G5.4 Use Trigonometry for right angled triangles to find missing angles

e.g
Find x in the triangle below



Remember SOHCAHTOA
Label the sides of the triangle you have with Opposite, Adjacent or Hypotenuse. Choose the correct trigonometric ratio to use. Substitute into the relevant formula and solve the equation using inverse functions

e.g
Label the triangle up

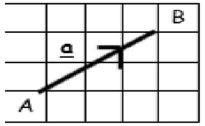


We have opp and adj so use Tan

$$\tan(x) = \frac{13}{5}$$
$$x = \tan^{-1}(\frac{13}{5})$$
$$x = 69.0°$$

G5.5 Use Vector column notation

e.g
Give the vector that represents a



In your vector the top value indicates spaces right or left (+ means right, - means left) and the bottom value means up or down (+ means up, - means down)

e.g
Moves 3 spaces right and 2 spaces up

so vector is $\binom{3}{2}$

G5: Pythagoras and Trigonometry

Add and subtract two column vectors

Use unknown vector notation

Know how to show two vectors are parallel

G5.6 Add and Subtract two column vectors

e.g

If $a = \begin{pmatrix} 4 \\ 7 \end{pmatrix}$ and $b = \begin{pmatrix} 2 \\ -3 \end{pmatrix}$ calculate

$a + b$

$a - b$

Vectors must have the same number of elements in them to be added or subtracted from each other. Match up each corresponding element and do the required calculation

e.g

$a + b$ gives $\begin{pmatrix} 4 \\ 7 \end{pmatrix} + \begin{pmatrix} 2 \\ -3 \end{pmatrix}$

$= \begin{pmatrix} 4+2 \\ 7 \pm -3 \end{pmatrix}$

$= \begin{pmatrix} 6 \\ 4 \end{pmatrix}$

$a - b$ gives $\begin{pmatrix} 4 \\ 7 \end{pmatrix} - \begin{pmatrix} 2 \\ -3 \end{pmatrix}$

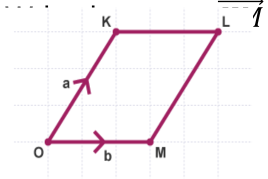
$= \begin{pmatrix} 4-2 \\ 7 - -3 \end{pmatrix}$

$= \begin{pmatrix} 2 \\ 10 \end{pmatrix}$

G5.7 and 5.8 Use unknown vector notation

e.g

in



Vectors are often represented simply using letters rather than numbers. These can be added and subtracted to find expressions for other unknown vectors

e.g

$\overrightarrow{KM} = \overrightarrow{KO} + \overrightarrow{OM}$

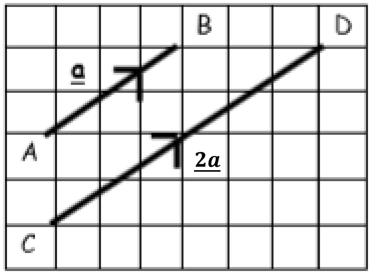
$\overrightarrow{KO} = -a$ and $\overrightarrow{OM} = b$

So $\overrightarrow{KM} = -a + b$ or $b - a$

G5.9 Know how to show two vectors are parallel

If two vectors are parallel one will be a multiple of the other

e.g



$\overrightarrow{AB} = a$ and $\overrightarrow{CD} = 2a$ as 2a is a multiple of a $\overrightarrow{AB}$ and $\overrightarrow{CD}$ ARE parallel

G5: Pythagoras and Trigonometry

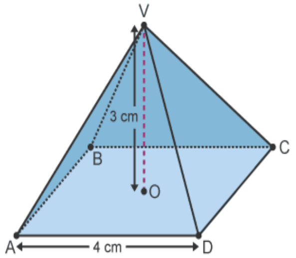
Use Pythagoras and trigonometry in 3D

Use the sine rule to find a missing side

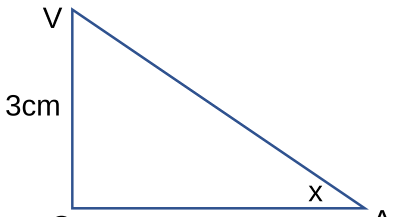
G5.10 and G5.11 Use Pythagoras and Trigonometry in 3D

e.g
ABCDV is a square based pyramid.
O is the **midpoint** of the square base ABCD.
Lengths AD, DC, BC and AB are all 4 cm.
The **perpendicular** height of the pyramid (OV) is 3 cm.

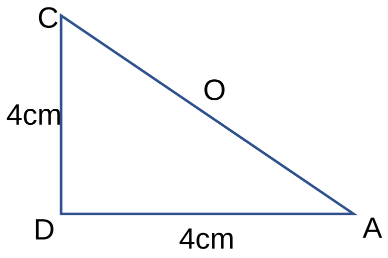
Find the angle between AV and the plane ABCD



Draw out 2D triangles that represent the lengths or angles that you are trying to calculate and apply Pythagoras and/or trigonometry as you would in a 2D shape e.g:The angle between AV and ABCD is represented by the triangle below



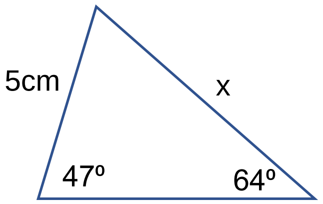
Either find length AV or length OA in order to use trigonometry to find x. We will find OA using the triangle below



Using Pythagoras' theorem from 5.1 AC is 5.66cm. As) is the midpoint of this line OA is 2.83cm. Use trigonometry to find an angle from section 5.4 on the top triangle the angle is 46.7º

G5.12 Use the sine rule to find a missing side

e.g
Find the missing side in the triangle below

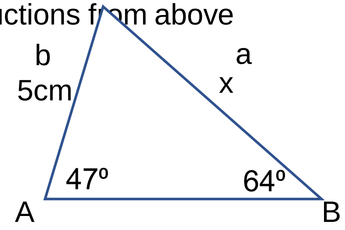


In order to find a missing side using Sine rule label the side you are trying to find as a and the angle that is opposite that as A. Then label the other side you know as b and the angle opposite that as B. Following that substitute into the below formula and solve for a

$$\frac{a}{sin(A)} = \frac{B}{\sin(B)}$$

e.g

First relabel the triangle using the instructions from above



Then substitute into the formula and solve

$$\frac{x}{\sin(47)} = \frac{5}{\sin(64)}$$

Multiply both sides by sin 47

$$x = \frac{5 \times \sin(47)}{\sin(64)}$$

$$x = 4.07cm$$

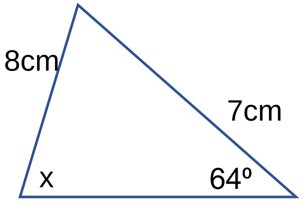
G5: Pythagoras and Trigonometry

Use the sine rule to find a missing angle

Use cosine rule to find a missing side

G5.13 Use the sine rule to find a missing angle

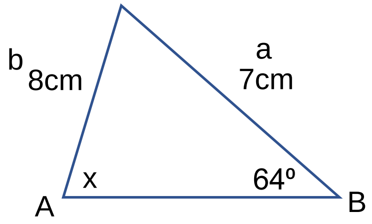
e.g
Find the missing angle in the triangle below



In order to find a missing angle using Sine rule label the angle you are trying to find as A and the side that is opposite that as a. Then label the other angle you know as B and the side opposite that as b. Following that substitute into the below formula and solve for A

$$\frac{\sin(A)}{a} = \frac{\sin(B)}{\text{b}}$$

e.g
First relabel the triangle using the instructions from above



Then substitute into the formula and solve

$$\frac{\sin(x)}{7} = \frac{\sin(64)}{8}$$

Multiply both sides by 7

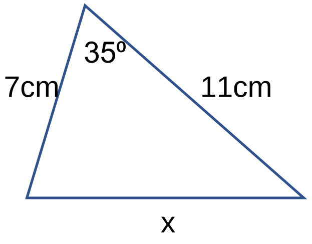
$$\sin(x) = \frac{7 \times \sin(64)}{8}$$

Take $\sin^{-1}$

$x = 51.9°$

G5.14 Use the cosine rule to find a missing side

e.g
Find the missing side in the triangle below

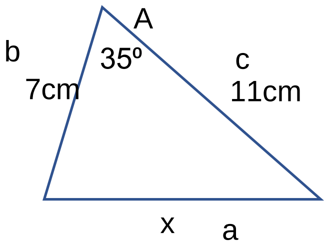


In order to find a missing side using Cosine rule label the side you are trying to find as a and the angle that is opposite that as A. Then label the other two sides you know as b and c (it doesn't matter which is which. Following that substitute into the below formula and solve for a

$$a^2 = b^2 + c^2 - 2bcCos(A)$$

e.g

First relabel the triangle using the instructions from above



Then substitute into the formula and solve

$$x^2 = 7^2 + 11^2 - 2 \times 7 \times 11 \times \cos(35)$$

Square root both sides

$$x = \sqrt{43.85}$$
$$x = 6.62cm$$

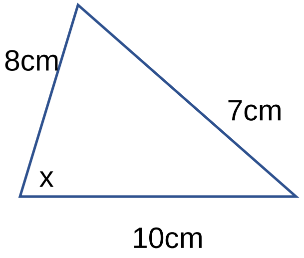
G5: Pythagoras and Trigonometry

Use the cosine rule to find a missing angle

Find the area of a triangle of unknown height or find a side or angle when given the area of a triangle

G5.15 Use the cosine rule to find a missing angle

e.g
Find the missing angle in the triangle below

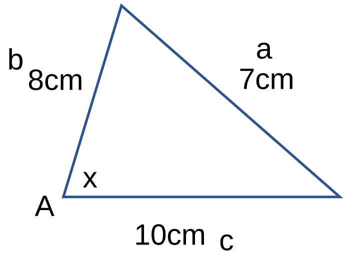


In order to find a missing angle using Sine rule label the angle you are trying to find as A and the side that is opposite that as a. Then label the other two sides you know as b and c (it doesn't matter which is which.) Following that substitute into the below formula and solve for A

$$\cos(A) = \frac{b^2 + c^2 - a^2}{2bc}$$

e.g

First relabel the triangle using the instructions from above



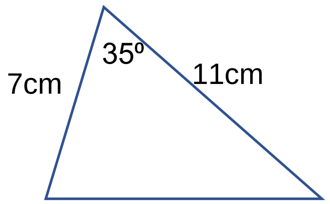
Then substitute into the formula and solve

$$\cos(A) = \frac{8^2 + 10^2 - 7^2}{2 \times 8 \times 10}$$

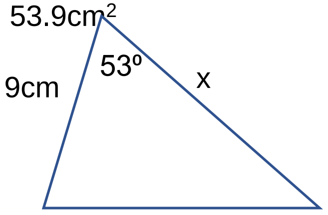
Take $\cos^{-1}$

$$x = 44.0°$$

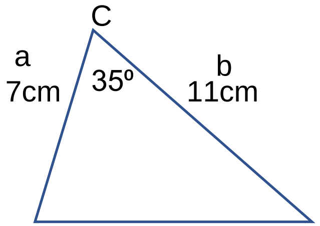
G5.16 and G5.17
Find the area of a triangle of unknown height or find a side or angle when given the area of a triangle
e.g Find the area of the triangle below



e.g Find the length of the unknown side given the area is 53.9cm²

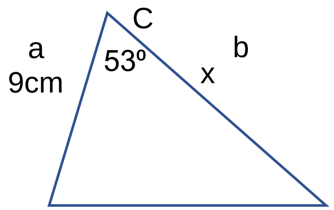


The formula for finding the area of a non- right angled triangle is
$Area = \frac{1}{2}absin(C)$ where a and b are known sides and C is a known included angle.
e.g
Label up the triangle and substitute into the formula



$$Area = \frac{1}{2} \times 7 \times 11 \times \sin(35)$$
$$Area = 22.1cm$$

e.g Label up the triangle as previously



Substitute into formula and solve for x using inverse functions

$$53.9 = \frac{1}{2} \times 9 \times x \times \sin(53)$$
$$x = 15.0cm$$

G5: Pythagoras and Trigonometry

Calculate the length of a vector

Prove that two vectors are parallel

Prove that two vectors are co-linear

G5.18 Calculate the length of a vector

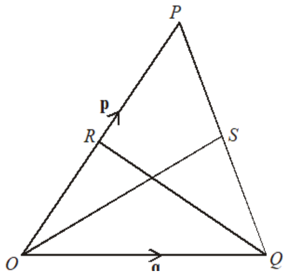
e.g Find the length of the vector $\begin{pmatrix} 3 \\ -4 \end{pmatrix}$

To calculate the length of a vector you use a simplified version of pythagroas' theorem. For a vector $\begin{pmatrix} x \\ y \end{pmatrix}$ you calculate $\sqrt{x^2 + y^2}$ to find the length
e.g

$$\sqrt{3^2 + -4^2}$$
$$vector\ length = 5\ units$$

G5.19 Prove that two vectors are parallel

e.g
OPQ is a triangle
$\overrightarrow{OQ} = q$ and $\overrightarrow{OR} = p$
R is the midpoint of $\overrightarrow{OP}$ and S is the midpoint of $\overrightarrow{PQ}$
Prove that $\overrightarrow{RS}$ and $\overrightarrow{OQ}$ are parallel

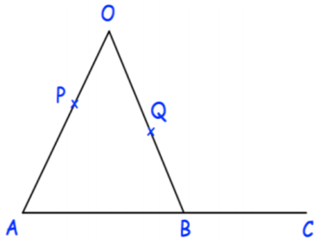


Use the skills built in G5.7/G5.8 and G5.9 to prove that two unknown vectors are parallel. Firstly by using vector notation to combine the vectors you require then showing that they are multiples of each other
e.g
For $\overrightarrow{RS}$ to be parallel to $\overrightarrow{OQ}$ it will need to be a multiple of q
$\overrightarrow{PQ} = \overrightarrow{PO} + \overrightarrow{OQ}$ so $\overrightarrow{PQ} = q - p$
$\overrightarrow{RS} = \overrightarrow{RP} + \overrightarrow{PS}$ and as R is the mid point of $\overrightarrow{OP}$ and S is the midpoint of $\overrightarrow{PQ}$ then $\overrightarrow{RP} = \frac{p}{2}$ and $\overrightarrow{PS} = \frac{q}{2} - \frac{p}{2}$
That means that $\overrightarrow{RS} = \frac{p}{2} + \frac{q}{2} - \frac{p}{2} = \frac{q}{2}$
Therefore $\overrightarrow{OQ} = \frac{\overrightarrow{RS}}{2}$ so $\overrightarrow{RS}$ and $\overrightarrow{OQ}$ are parallel

G5.20 Prove that two vectors are co-linear (lie in a straight line)

e.g
AOB is a triangle
P is a point on $\overrightarrow{AO}$
$\overrightarrow{AB} = 2a$, $\overrightarrow{AO} = 6b$ and
$\overrightarrow{AP}:\overrightarrow{PO} = 2:1$
B is the midpoint of $\overrightarrow{AC}$
Q is the midpoint of $\overrightarrow{OB}$

Prove that PQC is a straight line



To prove that two vectors are co-linear, or make a straight a straight line you need to prove that two vectors are parallel as in G5.19 but also that they both go through a common point
e.g
To prove that PQC is a straight line we will show that $\overrightarrow{PQ}$ and $\overrightarrow{PC}$ are parallel and as they both go through P they will make a straight line

$$\overrightarrow{OB} = \overrightarrow{OA} + \overrightarrow{AB} = 2a - 6b$$

$\overrightarrow{PQ} = \overrightarrow{PO} + \overrightarrow{OQ}$ where $\overrightarrow{PO} = \frac{\overrightarrow{AO}}{3} = 2b$
and $\overrightarrow{OQ} = \frac{\overrightarrow{OB}}{2} = \frac{2a-6b}{2} = a - 3b$
Therefore $\overrightarrow{PQ} = 2b + a - 3b = a - b$

$\overrightarrow{PC} = \overrightarrow{PA} + \overrightarrow{AC}$ where
$\overrightarrow{PA} = -\frac{2\overrightarrow{AO}}{3} = -4b$ and $\overrightarrow{AC} = 2\overrightarrow{AB} = 4a$
Therefore $\overrightarrow{PC} = -4b + 4a$ or $4a - 4b$

That means that $\overrightarrow{PC} = 4\overrightarrow{PQ}$ which proves that these two vectors are parallel. As they also both go through the common point P that proves that PQC is a straight line

N1: Calculating with Numbers

Understand the use of place value
Multiply by a two digit number
Multiply by 10, 100, 1000 etc,
Divide by a one digit number

N1.1 Understand the use of place value e.g. What value is the 6 in the number 6700	Th H T U. 6 7 0 0 The '6' is in the thousands column. Therefore the value of the 6 is six thousand.
N1.2 Multiply by a two-digit number e.g. 152 x 34	Draw a grid. Write the hundreds, tens and units across the top. Write the tens and units down the side. Multiply each number together. Add all the numbers from inside the box.

	100	50	2
30	3000	1500	60
4	400	200	8

152 x 34 = 3400 +1700+ 68 = **5168**

N1.3 Multiply by 10, 100, 1000 etc. e.g. 3.52 x10 3.52 x 100 3.52 x 1000	To multiply by powers of ten, move all the digits to the left by the same number of places as the power 3.52 x 10 = 35.2 (move 1 place) 3.52 x 100 = 352 (move 2 places) 3.52 x 1000 = 3520 (move 3
N1.4 Divide by a one-digit number e.g. 756 ÷ 3	Draw a bus stop. The number you divide by goes on the outside. Divide the number into the first number underneath. If it does not go, write 0 on top and carry the number underneath. Divide into the next number.

	2	5	2
3	7	5	6
	-6	↓	
	1	5	↓
	1	5	
		0	6

e.g. 756 ÷ 3 =252

N1: Calculating with Numbers

Divide by a two digit number
Use BIDMAS to order operations
Add and subtract decimals
Multiply decimals

N1.5
Divide by a two-digit number

e.g. 4928 ÷ 32

Draw a bus stop.
The number you divide by goes on the outside.
Divide the number into the first number underneath.
If it does not go, write 0 on top and carry the number underneath.
Divide into the next number.

		0	1	5	4
3	2	4	9	2	8
		-3	2	↓	
		1	7	2	↓
		-1	6	0	
			1	2	8
			-1	2	8

4928 ÷ 32 = 154

N1.6
Use BIDMAS to order operations

e.g. 3 + 4 x 6 - 5

Bracket
Indices
Divide
Multiply } Do these in the order they appear
Add
Subtract } Do these in the order they appear

e.g. 3 + 4 x 6 - 5 = 22
(4 x 6 ↑ first)

N1.7
Add and subtract decimals

e.g. 4.32 + 5.6

```
  4.32
+ 5.60
  9.92
```

Line up the decimal point.
Fill any blank spaces with 0.
Add the numbers starting from the right.
4.32 + 5.6 = 9.92

N1.8
Multiply Decimals

e.g. 2.5 x 1.1

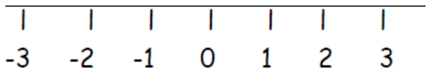
Take out the decimal points.
Multiply as with long multiplication.
Put the decimal back in.

e.g. 2.5 x 1.1
25 x 11 = 275
There are 2 decimal places in the question, so the answer is 2.75

2.5 x 1.1 = 2.75

N1: Calculating with Numbers

Divide by decimals
Order negative numbers
Add and subtract negative numbers
Multiply and divide by negative numbers

N1.9 Divide by decimals e.g. 2.84 ÷ 0.2	Make the divisor into a whole number. Multiply both numbers. e.g. 2.84 ÷ 0.2 (multiply both by 10) 28.4 ÷ 2 = 14.1 2.84 ÷ 0.2 = 14.1
N1.10 Order negative numbers e.g. order the numbers in ascending order: -3, 5, -1, -2, 0	 2 > -2 → We say 2 is bigger than -2 -1 < 3 → We say -1 is less than 3 -3, -2, -1, 0, 5

N1.11 Add and subtract negative numbers e.g. 8 + -2 8 - +2 8 - -2	Remember the rules: • When subtracting go down the number line • When adding go up the number line • 8 + - 2 is the same as 8 - 2 = 6 • 8 - + 2 is the same as 8 - 2 = 6 • 8 - - 2 is the same as 8 + 2 = 10
N1.12 Multiply and divide by negative numbers e.g. -8 x -2 -8 ÷ -2	When multiplying negatives remember: + x + = + + x - = - - x + = - - x - = + When dividing negatives remember: + x + = + + x - = - - x + = - - x - = + 8 x -2 = -16 -8 ÷ -2 = 4

N1: Calculating with Numbers

Use one calculation to work out another

Use a calculator efficiently for simple calculations

Use a calculator efficiently for powers, roots and more complex calculations

N1.13 Use one calculation to work out another e.g. 24 x 36 = 864, what is 2.4 x 3.6?	24 x 36 = 864 864÷24=36 864 ÷36=24 24 x 36 = 864 2.4 x36=86.4 2.4x3.6=8.64 (Notice how the sum changes & so does the answer) 24 x 36 = 864 86.4÷24=3.6 8640 ÷36=240 (Notice how the sum changes & so does the answer) 24 x 36 = 864 864÷2.4=360 864 ÷360=2.4 (Notice how the sum changes & the answer does the opposite)
N1.14 Use a calculator efficiently for simple calculations	Know your keys Addition: + Subtraction: - Multiply: x Divide: ÷ Equals: = Brackets: ()

N1.15 Use a calculator efficiently for powers, roots and more complex calculations	Know your keys x^2 Square key x^3 Cube key $x^{\blacksquare}$ Power key $\sqrt{}$ Square root key $\sqrt[3]{}$ Cube root key (-) Negative key $\frac{\blacksquare}{\square}$ Fraction key

N2: Fractions, Decimals and Percentages

Write equivalent fractions
Simplify a fraction
Add and subtract fractions (same denominator)
Add fractions (different denominators)
Subtract fractions (different denominators)

N2.1 Write equivalent fractions e.g. write equivalent fractions for: $\frac{4}{5}$	To write an equivalent fraction you must multiply the numerator and denominator by the same number. $\frac{4}{5} = \frac{16}{20}$ (multiply by 4) $\frac{4}{5} = \frac{40}{50}$ (multiply by 10) $\frac{4}{5} = \frac{8}{10}$ (multiply by 2)
N2.2 Simplify a fraction e.g. simplify: $\frac{8}{12}$ $\frac{15}{40}$	See what number divides exactly into both the numerator and denominator e.g. $\frac{8}{12} \xrightarrow{\div 4} \frac{2}{3}$ e.g. $\frac{15}{40} \xrightarrow{\div 5} \frac{3}{8}$

N2.3 Add and subtract fractions (same denominator) e.g. $\frac{2}{3} + \frac{2}{3}$	Add & subtract with same denominator e.g. $\frac{2}{3} + \frac{2}{3} = \frac{4}{3} = 1\frac{1}{3}$
N2.4 Add fractions (different denominators) e.g. $\frac{1}{5} + \frac{7}{10}$	Make denominators the same then add the numerators e.g. $\frac{1}{5} + \frac{7}{10}$ $= \frac{2}{10} + \frac{7}{10}$ $= \frac{9}{10}$
N2.5 Subtract fractions (different denominators) $\frac{4}{5} - \frac{2}{3}$	Make denominators the same then subtract the numerators $\frac{4}{5} - \frac{2}{3}$ $= \frac{12}{15} - \frac{10}{15}$ $= \frac{2}{15}$

N2: Fractions, Decimals and Percentages

Multiply fractions
Find a fraction of a quantity
Divide a fraction by a whole number
Order fractions
Convert common fractions, decimals and percentages

N2.6 Multiply fractions e.g. $\frac{2}{7} \times \frac{2}{3}$	When multiplying fractions, multiply the numerators and multiply the denominators. Cancel down if possible before or after the calculation. $\frac{2}{7} \times \frac{2}{3} = \frac{4}{21}$
N2.7 Find fraction of a quantity e.g. Find $\frac{4}{5}$ of £40	**$\frac{4}{5}$ means ÷ 5 x 4.** e.g. To find $\frac{4}{5}$ of £40 £40 ÷ 5 x 4 = £32
N2.8 Divide a fraction by a whole number e.g. $\frac{2}{7}$ ÷ 3	Make the whole number a fraction e.g. 3 becomes $\frac{3}{1}$ Then Keep Change Flip: Keep first fraction the same Change ÷ to x Flip the second fraction and calculate $\frac{2}{7} \times \frac{1}{3} = \frac{2}{21}$

N2.9 Order fractions e.g. order: $\frac{5}{6}, \frac{7}{12}, \frac{2}{3}, \frac{3}{4}$	Fractions must have the same denominator They must have the same denominator e.g. $\frac{5}{6}$ → $\frac{10}{12}$, $\frac{7}{12}$ → $\frac{7}{12}$, $\frac{2}{3}$ → $\frac{8}{12}$, $\frac{3}{4}$ → $\frac{9}{12}$ $\frac{7}{12}, \frac{2}{3}, \frac{3}{4}, \frac{5}{6}$
N2.10 Convert common fractions, decimals and percentages e.g. 0.5, 0.25	LEARN THESE = 0.25 = 25% = ¼ = 0.5 = 50% = ½ = 0.75 = 75% = ¾

N2: Fractions, Decimals and Percentages

Order decimals
Find a percentage of a quantity
Converting fractions to decimals

Convert a decimal to a fraction
Convert from a percentage to a decimal to a fraction
Convert from a decimal to a percentage to a fraction
Convert fractions to decimals to percentages

N2.11 Order decimals e.g. order: 0.3, 0.304, 0.32, 0.33	Decimals need the same number of digits Give them all the same number of digits e.g. 0.3, 0.304, 0.32, 0.33 ↓ 0.300 0.304 0.320 0.330 Now the decimals can be ordered 0.3, 0.304, 0.32, 0.33
N2.12 Find percentage of a quantity e.g. 8% of £240 12.5% of 80kg 80% of 52 litres	e.g. 8% of £240 = 0.08 x 240 = <u>£19.20</u> $12\frac{1}{2}$ % of 80kg = 0.125 x 80 = <u>10kg</u> 80% of 52 litres = 0.8 x 52 = <u>41.6 litres</u>
N2.13 Converting fraction to decimal e.g. $\frac{4}{5}$ $\frac{9}{12}$ $\frac{3}{8}$	<u>Fractions to decimals</u> - by changing e.g. $\frac{4}{5} = \frac{8}{10} = 0.8$ e.g. $\frac{9}{12} = \frac{3}{4} = 0.75$ <u>Fractions to decimals</u> - by dividing e.g. $\frac{3}{8} = 3 \div 8 = 0.375$

N2.14 Convert decimal to a fraction e.g. 0.74	To convert see what column the number ends in. In this case the hundredths. Therefore put the number over 100 and simplify. $0.74 = \frac{74}{100} = \frac{37}{50}$
N2.15 Convert from percentage to decimal to fraction e.g. 27% 7% 70%	$27\% = 0.27 = \frac{27}{100}$ $7\% = 0.07 = \frac{7}{100}$ $70\% = 0.7 = \frac{70}{100} = \frac{7}{10}$
N2.16 Convert from decimal to percentage to fraction e.g. 0.3 0.03 0.39	$0.3 = 30\% = \frac{3}{10}$ $0.03 = 3\% = \frac{3}{100}$ $0.39 = 39\% = \frac{39}{100}$
N2.17 Convert fractions to decimals to percentages e.g. $\frac{4}{5}$ $\frac{3}{8}$	$\frac{4}{5} = \frac{80}{100} = 80\% = 0.8$ *Change to 100* $\frac{3}{8} = 3 \div 8 = 0.375 = 37.5\%$

N2: Fractions, Decimals and Percentages

Divide fractions
Increase by a percentage
Decrease by a percentage
Order fractions, decimals and percentages

N2.18 Divide fractions e.g. $\frac{2}{7} \div \frac{2}{3}$	Invert fraction after ÷ Multiply numerator Multiply denominators. Keep Change Flip $\frac{2}{7} \div \frac{2}{3} = \frac{2}{7} \times \frac{3}{2}$ $= \frac{6}{14} = \frac{3}{7}$
N2.19 Increase by a percentage e.g. Increase £12 by 5%	• **To increase £12 by 5%** 10% of £12 = £1.20 5% of £12 = £0.60(OR 0.05 x 12 = 0.6) *Increased amount=£12 + £0.60=£12.60* If using a calculator: Multiplier needed to increase a quantity. To increase a quantity by 5% Multiply the quantity by 1.05 (100 + 5 = 105) 12 x 1.05 = £12.60

N2.20 Decrease by a percentage. e.g. Decrease £50 by 15%	• **To decrease £50 by 15%** 10% of £50 =£5 5% of £50 = £2.50 15% of £50 = £7.50(OR 0.15x50=7.5) *Decreased amount = £50-£7.50=£42.50* If using a calculator: Multiplier needed to decrease a quantity. To decrease a quantity by 15%. Multiply the quantity by 0.85 (100 - 15) 50 x 0.85 = £42.50
N2.21 Order Fractions, Decimals, Percentages e.g. Order: $0.3, \frac{3}{5}, 40\%, 0.56$	You need to convert them all to the same form. In this case it is easier to convert all to decimals and then order 0.3 $\frac{3}{5}$ = 0.6 40% = 0.4 0.56 Therefore the correct order in ascending order is: 0.3, 40%, 0.56, $\frac{3}{5}$

N2: Fractions, Decimals and Percentages

Change a recurring decimal into a fraction

Prove that a recurring decimal is equal to a fraction

N2.22 Change a recurring decimal into a fraction e.g. Convert = 0.44444444444 into a fraction	Set the recurring decimal = x. Multiply by a power of 10. The power is the same as the number of digits recurring. Subtract the smaller decimal from the larger. This will give an equation. Solve the equation, leaving your answer as a fraction in its simplest terms. Let x = 0.44444444444… 10x = 4.4444444444… 9x = 4 x = $\frac{4}{9}$
N2.23 Prove that a recurring decimal is equal to a fraction e.g. prove that 0.44444 = $\frac{4}{9}$	A proof will need every step clearly written. Use the method shown in N2.22.

N3: Accuracy and Measures

Round to the nearest 1,10,100 etc

Round to 1 decimal place.

Round to 1 or more decimal places

Round to 1 significant figure

N3.1
Round to the nearest 1, 10, 100 etc.

Numbers can be **rounded to the nearest whole number, the nearest ten**, the **nearest hundred**, the **nearest thousand**, the **nearest** million, and so on.
If the digit you are **rounding** is followed by a 5, 6, 7, 8, or 9, **round** the number up. If the number you are **rounding** is followed by a 0, 1, 2, 3, or 4, **round** the number down.

Round 2548.6 to the nearest 1, 10, 100 & 1000.

1	10	100	1000
2549	2550	2500	3000

N3.2
Round to 1 decimal place.

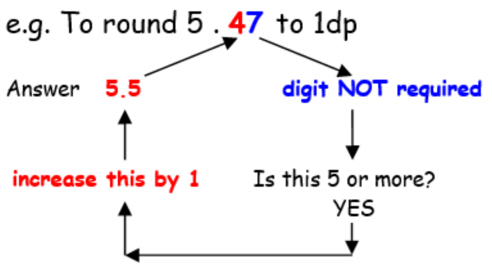
Numbers can be **rounded to one decimal place**.
If the digit in the 2nd decimal place is a 5, 6, 7, 8, or 9, **round** the number up. If it is a 0, 1, 2, 3, or 4, **round** the number down.

Round to 1 decimal place:
a) 34.64
b) 53.271
c) 102.956

a) 34.6
b) 53.3
c) 103.0

N3.3
Round to 1 or more decimal places.

- Look at the digit required
- Look at the first digit NOT required



a) Round 43.568
b) to 2dp.
b) Round 5.6741
to 3dp.
c) Round 4.7955
to 2dp.

a) 43.57
b) 5.674
c) 4.80

N3.4
Round to 1 significant figure.
The first s.f. is the first non-zero digit from the left.

Look at the first non-zero digit.
Look at the next digit.
If this next digit is **5 or more**, increase the previous digit by one
If this next digit is **4 or less**, keep the previous digit the same
Replace all the digits after the first non-zero digit with zeros, stopping at the decimal point if there is one.

Round to 1 significant figure:
a) 289.6
b) 4489
c) 0.000763

a) 300
b) 4000
c) 0.0008

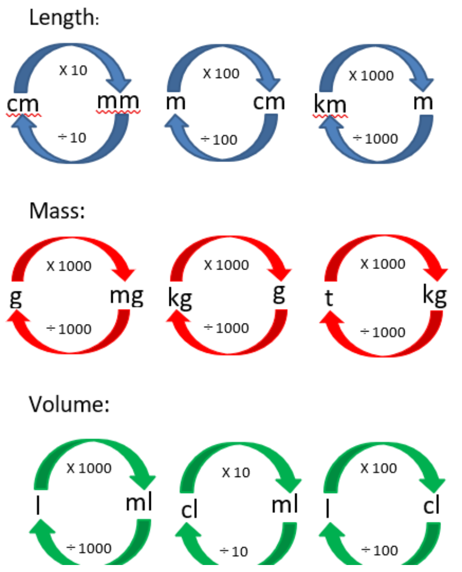
N3: Accuracy and Measures

Round to 2 or more significant figures

Estimate a calculation using rounding

Calculate with metric units

N3.5 Round to 2 or more significant figures. a) Round 65590 to 2sf. b) Round 674.82 to 3sf. c) Round 0.01362 to 2sf.	Look at the digit after the first non-zero digit. Look at the next digit. If this next digit is **5 or more**, increase the previous digit by one. If this next digit is **4 or less**, keep the previous digit the same. Replace all these other digits with zeros, stopping at the decimal point if there is one a) 66000 b) 675 c) 0.014
N3.6 Estimate a calculation using rounding. Estimate: a) 423 x 28 b) 1589 ÷ 0.473	When estimating always round each number to 1 significant figure first. a) 400 x 30 = 12000 b) 2000 ÷ 0.5 = 4000

N3.7 Calculate with metric units. Convert : a) 6m to cm b) 7200g to kg c) 34cl to l	 a) 6 x 100 = 600cm b) 7200 ÷ 1000 = 7.2 kg c) 34 ÷ 100 = 0.34 l

N3: Accuracy and Measures

Calculate with time
Calculate with money
Convert units of time

N3.8 Calculate with time.	For adding time: 1) Add the hours 2) Add the minutes 3) It the minutes are 60 or more subtract 60 from the minutes and add 1 hour.
What is 2:45 + 1:20?	Add the hours, 2 + 1 = 3. Add the minutes 45 + 20 = 65. The minutes are more than 60, so subtract 60 from the minutes, 65 – 60 = 5, and add 1 to the hours, 3 + 1 = 4. The answer is 4:05. For subtracting time: 1) Subtract the hours 2) Subtract the minutes 3) If the minutes are negative add 60 to the minutes and subtract 1 hour.
What is 9:15 - 3:35?	Subtract the hours, 9 - 3 = 6 Subtract the minutes 15 - 35 = -20 The minutes are negative, so add 60 to the minutes, -20 + 60 = 40, and subtract 1 from the hours, 6 - 1 = 5. The answer is 5:40.

N3.9 Calculate with money.	Use the same method of adding numbers that have 2 decimal places.
Richard buys a notebook that costs £6.78 and a pen that costs £4.19. Work out the total cost.	6.78 + 4.19 10.97 1 Total cost = £10.97
N3.10 Convert units of time.	1 century = 100 years 1 decade = 10 years 1 year = 365 days (except leap years) 1 day = 24 hours 1 hour = 60 minutes 1 minute = 60 seconds
How many seconds are there in 1 week?	7 x 24 x 60 x 60 = 604,800 seconds

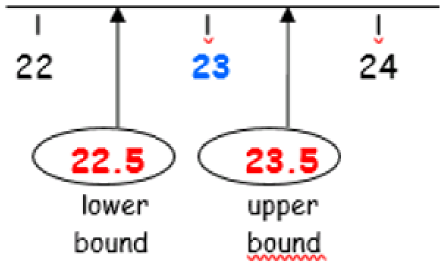
N3: Accuracy and Measures

Write the upper bound and lower bound of a number or measurement
State an error interval for a rounded number
State an error interval for a truncated number
Calculate using the compound measure speed

N3.11
Write the upper bound and lower bound of a number or measurement

Bounds tell us the largest possible value of a number and the smallest possible value.

What is the lower and upper bound of 23cm if rounded to the nearest centimetre?



N3.12
State an error interval for a rounded number

Lower and upper bounds can be written as error intervals with the use of inequalities.

Look out for the word “rounded” when doing this type of error interval.

The mass m of a table is 45.7kg rounded to 1dp. Write the error interval for this.

$45.65 \le m < 45.75$ kg

N3.13
State an error interval for a truncated number.

Lower and upper bounds can be written as error intervals with the use of inequalities.

Look out for the word “truncated” when doing this type of error interval.

The volume v of a tank is 78.7 litres truncated to 1dp. Write the error interval for this.

$78.7 \le v < 78.8$ litres

N3.14
Calculate using the compound measure speed.

Use this triangle to help you to remember the different formulae. Cover up the quantity that you want to calculate

S = D ÷ T
D = S x T
T = D ÷ S

How long does a journey last if a car travels 180 miles at an average speed of 40 mph?

Time taken = 180 ÷ 40 = 4.5 hours

N3: Accuracy and Measures

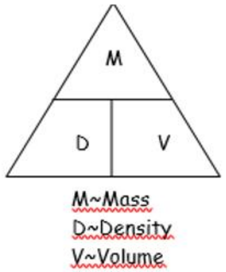
Calculate using the compound measure density

Use bounds to find the upper limit or lower limit of a calculation

N3.15
Calculate using the compound measure density.

Use this triangle to help you to remember the different formulae. Cover up the quantity that you want to calculate.

D = M ÷ V
M = D x V
V = M ÷ D



What is the density of a rod of aluminium that has a mass of 575.4g and a volume of 210cm³

Density = 575.4 ÷ 210 = 2.74 g/cm³

N3.16
Use bounds to find the upper limit or lower limit of a calculation

If a is rounded to the nearest x
Upper bound = a + ½ x.

Lower bound = a – ½ x.

1.8 is rounded to 1 dp.
Upper bound = 1.8 + ½(0.1)
= 1.85
Lower bound = 1.8 - ½(0.1)
= 1.75

Calculating using bounds.

Adding:	
Maximum = upper + upper	1.85 + 1.85 = 3.70
Minimum = lower + lower	1.75 + 1.75 = 3.50
Subtracting:	
Maximum = upper – lower	1.85 – 1.75 = 0.10
Minimum = lower – upper	1.75 – 1.85 = -0.10
Multiplying:	
Maximum = upper x upper	1.85 x 1.85 = 3.4225
Minimum = lower x lower	1.75 x 1.75 = 3.0625
Dividing:	
Maximum = upper ÷ lower	1.85 ÷ 1.75 = 1.06 (2 dp)
Minimum = lower ÷ upper	1.75 ÷ 1.85 = 0.95 (2 dp)

N4: Factors, Multiples and Primes

Understand the term factor
Understand the term Prime
Understand the term multiples
Understand the term square

Understand the term cube
Calculate the power of a number
Calculate the root of a number

N4.1 Understand the term 'factor'. e.g. define a factor.	**<u>FACTORS</u> are what divides exactly into a number** Factors of 12 are: 1 12 2 6 3 4
N4.2 Understand the term 'prime'. e.g. define a prime.	**<u>PRIMES</u> have exactly TWO factors** Factors of 7 are 1 and 7 **<u>7 is PRIME</u>**
N4.3 Understand the term 'multiple. e.g. define a multiple.	**Multiples are what you get when you multiply a number by successive numbers** Multiples of 12 are: 12 (= 12 x 1), 24 (= 12 x 2), 36 (= 12 x 3), and so on.
N4.4 Understand the term 'square'. e.g. define a square number.	**<u>SQUARES</u> are the result of multiplying a number by itself** 3 x 3 = 3^2 = 9 8 x 8 = 8^2 = 64 **9 & 64 are square numbers**

N4.5 Understand the term 'cube'. e.g. define a cube number.	**<u>Cubes</u> are the result of multiplying a number by itself and by itself again** 2 x 2 x 2 = 2^3 = 8 4 x 4 x 4 = 4^3 = 64 **8 & 64 are cube numbers**
N4.6 Calculate the power of a number. e.g. Calculate 4^2. Calculate 5^3. Calculate 3^4.	4^2 is 4 **squared**, or the square of 4. It means 4 x 4 = 16 5^3 is 5 **cubed**, or the cubes of 5. It means 5 x 5 x 5 = 125 3^4 is 3 **to the power of** 4. It means 3 x 3 x 3 x 3 = 81
N4.7 Calculate the root of a number. e.g. Calculate $\sqrt{16}$ $\sqrt[3]{125}$ $\sqrt[4]{81}$	The **inverse** operation for '**power**' is '**root**' $\sqrt{16} = 4$ $\sqrt[3]{125} = 5$ $\sqrt[4]{81} = 3$ **There are keys on the calculator to all of these**

N4: Factors, Multiples and Primes

Find factors of a number
Find multiples of a number
Identify a prime number

N4.8 Find Factors of a number. e.g. find the factors of 24.	<u>**FACTORS**</u> **are what divides exactly into a number** You can find factors using factor pairs: <u>Factors of 24</u> 1 x 24 2 x 12 3 x 8 4 x 6 **1, 2 , 3, 4, 6, 12 and 24 are all factors of 24**
N4.9 Find Multiples of a number. e.g. list the first 6 multiples of 5.	<u>**Multiples**</u> **are the numbers in a times table** The first 6 multiples of 5 are… 5, 10, 15, 20, 25, 30

N4.10 Identify a Prime Number. e.g. list the prime numbers less than 30.	<u>**Prime numbers**</u> only have two factors, 1 and themselves. These are the only numbers you can divide into a prime number <u>Factors of 17</u> 1 x 17 only 17 ÷ 1 = 17 17 ÷ 17 = 1 **This means 17 is a prime number.** **2 is the only even prime number.** **1 isn't a prime number**
	The prime numbers less than 30 are… **2, 3, 5, 7, 11, 13, 17, 19, 23, 29**

N4: Factors, Multiples and Primes

Find the highest common factor of two or more numbers

Find the lowest common multiple of two or more numbers

N4.11 Find the Highest Common Factor (HCF) of two or more numbers. e.g. find the HCF of 36 and 54.	Find the factors of the numbers. The **highest common factor (HCF)** is the biggest factor that is common to both. **<u>HCF of 36 and 54</u>** Factors of 36: 1 x 36, 2 x 18, 3 x 12, 4 x 9, 6 x 6 Factors of 54: 1 x 54, 2 x 27, 3 x 18, 6 x 9 18 is the biggest factor of both, and so… **the HCF of 36 and 54 is 18** You would never be asked to find the lowest common factor as 1 is a factor of all numbers. This means there will always be an HCF for two or more numbers.

N4.12 Find the Lowest Common Multiple (LCM) of two or more numbers. e.g. find the LCM of 9 and 12.	List the multiples (times tables) of the numbers. The **Lowest Common Multiple (LCM)** is the first number common to both (in both lists). **<u>LCM of 9 and 12</u>** Multiples of 9 9, 18, 27, 36, 45, 54, 63, 72, 90… Multiples of 12 12, 24, 36, 48, 60, 72, 84…. **The LCM of 9 and 12 is 36** (note that 72 is also common to both, but this isn’t the lowest) You would never be asked for the highest common multiple, as there are an infinite number of common multiples.

N4: Factors, Multiples and Primes

Write a number as its product of prime factors

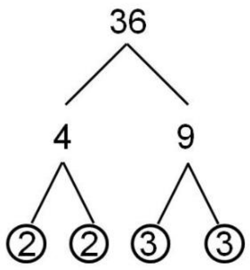
Write large numbers in standard form

N4.13
Write a number as its product of prime factors.

e.g. write 36 as the product of its prime factors.

To find the **product of prime factors** for a number, produce a factor tree. Stop when you get to prime numbers, which you circle

<u>Product of prime factors for 36</u>



36 = 2 x 2 x 3 x3
(product of prime factors)

$36 = 2^2 \times 3^2$
(index form)

N4.14
Write large numbers in standard form.

e.g.
Write 50000 in standard form

Write 320000 in standard form

Standard Form is a shorthand method for writing large and small numbers.

<u>Large Numbers in Standard Form</u>

$5 \times 10^4 = 5000$

A number between 1 and 9.9 recurring

A power of 10

$3.2 \times 10^5 = 320\ 000$

46×10^3 not standard form

$= 4.6 \times 10^4$

$= 46\ 000$

N4: Factors, Multiples and Primes

Write small numbers in standard form

Write a number in standard form as a regular number

N4.15
Write small numbers in standard form.

e.g.
Write 0.005 in standard form

Write 0.000041 in standard form

Standard Form is a shorthand method for writing large and small numbers.

Small Numbers in Standard Form

$5 \times 10^{-3} = 0.005$

3 zeros before the 5

A number between 1 and 9.9 recurring

A power of 10

$4.1 \times 10^{-5} = 0.000041$

32×10^{-4} not standard form

$= 3.2 \times 10^{-3}$

$= 0.0032$

N4.16
Write a number given in standard form as a regular number

e.g.
Write 5×10^4 as a number

Write 5×10^{-3} as a number.

Positive Powers

5×10^4

$= 5 \times 10000$

$= 50000$

The digit 5 has moved 4 places to the left.
Positive power moves to the left by the number of places equal to the index number

Negative Powers

$5 \times 10^{-3} =$

0.005

The digit moves 3 places to the right.
Negative power moves to the left by the number of places equal to the number in the index.

N4: Factors, Multiples and Primes

Apply the law of indices for multiplying powers
Apply the law of indices for dividing powers
Apply the law of indices for powers of powers
Evaluate fractional indices

N4.17 Apply the law of indices for multiplying powers. e.g. simplify $5^3 \times 5^6$ $4^7 \times 4^{-2}$	When **multiplying indices** add the powers $5^3 \times 5^6 = 5^9$ $4^7 \times 4^{-2} = 4^5$
N4.18 Apply the law of indices for dividing powers. e.g. simplify $\frac{8^7}{8^2}$ $\frac{6^2}{6^9}$	When **dividing indices** subtract the powers $\frac{8^7}{8^2} = 8^5$ $\frac{6^2}{6^9} = 6^{-7}$ When applying the laws of indices the base number (the 8 and the 6 in the above examples) must be the same.

N4.19 Apply the law of indices for powers of powers e.g. simplify $(4^6)^2$ $(6^3)^5$ $(7^5)^{-4}$	Multiply out the brackets $(4^6)^2 = 4^6 \times 4^6$ $= 4^{12}$ $(6^3)^5 = 6^{15}$ $(7^5)^{-4} = 7^{-20}$
N4.20 Evaluate fractional indices e.g. evaluate $16^{\frac{1}{2}}$ $8^{\frac{1}{3}}$ $25^{\frac{3}{2}}$	**Fractional indices** are roots. 'Evaluate' means to show your answer as a number value, and not as an index power. $16^{\frac{1}{2}} = \sqrt{16} = 4$ $8^{\frac{1}{3}} = \sqrt[3]{8} = 2$ $25^{\frac{3}{2}} = (\sqrt{25})^3 = 125$ Denominator is the root, numerator the power.

N4: Factors, Multiples and Primes

Evaluate negative indices

Evaluate indices involving both negative and fractional

Simplify a surd

Simplify a surd expression

N4.21 Evaluate negative indices e.g. evaluate 4^{-2} 10^{-3}	**Negative indices** are equivalent to fractions and decimals. $4^{-2} = \frac{1}{4^2} = \frac{1}{16}$ $10^{-3} = \frac{1}{10^3} = \frac{1}{1000} = 0.001$ Give your answer as a fraction unless told otherwise.
N4.22 Evaluate indices involving both negative and fractional e.g. evaluate $16^{-\frac{3}{2}}$	$16^{-\frac{3}{2}}$ Turn into a fraction. Denominator is the root, numerator the power. $= \frac{1}{(\sqrt{16})^3} = \frac{1}{64}$

N4.23 Simplify a surd e.g. simplify $\sqrt{18}$ $\sqrt{75}$	$\sqrt{25}$ is <u>NOT</u> a surd because it is exactly 5. $\sqrt{3}$ is a surd because the answer is not exact. **A surd is an irrational number** **To simplify surds look for square number factors** $\sqrt{18} = \sqrt{9} \times \sqrt{2} = 3\sqrt{2}$ $\sqrt{75} = \sqrt{25} \times \sqrt{3} = 5\sqrt{3}$
N4.24 Simplify a surd expression e.g. simplify $5\sqrt{3} + 2\sqrt{3}$ $5\sqrt{3} \times 2\sqrt{3}$	$5\sqrt{3} + 2\sqrt{3} = 7\sqrt{3}$ When adding the root stays the same $5\sqrt{3} \times 2\sqrt{3} = 10\sqrt{9}$ $= 10 \times 3 = 30$

N4: Factors, Multiples and Primes

Rationalise the denominator of a fraction

Multiply two surd brackets together

N4.25

Rationalise the denominator of a fraction (simple surd)

e.g. Rationalise $\frac{3}{\sqrt{2}}$

Rationalising the denominator of a surd is removing the surd from the denominator of a fraction by multiplying the numerator and denominator of that fraction by the denominator.

In general:

$$\frac{a}{\sqrt{b}} \text{ x } \frac{\sqrt{b}}{\sqrt{b}} = \frac{a\sqrt{b}}{b}$$

Example:

$$\frac{3}{\sqrt{2}} \text{ x } \frac{\sqrt{2}}{\sqrt{2}} = \frac{3\sqrt{2}}{2}$$

These are equivalent fractions

N4.26

Multiply two surd brackets together

e.g. simplify fully

$(5-\sqrt{3})(1+\sqrt{3})$

Multiply **surd brackets** together in the same way you would in algebra with double brackets to form a quadratic expression. Using the grid method is the most straightforward way.

Example:

Simplify fully

$(5-\sqrt{3})(1+\sqrt{3})$

x	1	$\sqrt{3}$
5	5	$5\sqrt{3}$
$-\sqrt{3}$	$-\sqrt{3}$	-3

$= 5 - \sqrt{3} + 5\sqrt{3} - 3$

Collecting terms gives…

$= 4\sqrt{3} + 2$

N4: Factors, Multiples and Primes

Rationalise the denominator of a fraction (surd expression)

Calculate with numbers in standard form

N4.27 Rationalise the denominator of a fraction (surd expression) e.g. rationalise this surd $\frac{5}{3-\sqrt{2}}$	**Rationalising the denominator** of a surd is removing the surd from the denominator of a fraction by multiplying the numerator and denominator of that fraction by the denominator. **Example**: Rationalise this surd $\frac{5}{3-\sqrt{2}}$ $\frac{5}{3-\sqrt{2}} \times \frac{(3+\sqrt{2})}{(3+\sqrt{2})}$ $= \frac{5(3+\sqrt{2})}{(3-\sqrt{2})(3+\sqrt{2})}$ $= \frac{15+5\sqrt{2}}{9+3\sqrt{2}-3\sqrt{2}-2}$ $= \frac{15+5\sqrt{2}}{7}$

N4.28 Calculate with numbers in standard form (1) e.g. calculate, giving your answer in standard form, $(3 \times 10^4) \times (2 \times 10^6)$ $(4 \times 10^4) \times (6 \times 10^6)$ $(8 \times 10^9) \div (4 \times 10^3)$	When **multiplying in standard form,** use the laws of indices for the powers, while multiplying the whole numbers as usual. $(3 \times 10^4) \times (2 \times 10^6) = 6 \times 10^{10}$ $(4 \times 10^4) \times (6 \times 10^6)$ $= 24 \times 10^{10}$ $= 2.4 \times 10^{11}$ Make sure numbers are in standard form. When **dividing in standard** form, use the laws of indices for the powers, while dividing the whole numbers as usual. $(8 \times 10^9) \div (4 \times 10^3) = 2 \times 10^6$

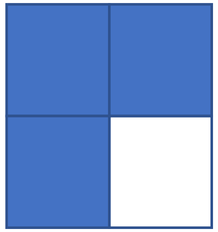
N4: Factors, Multiples and Primes

Calculate with numbers in standard form continued

N4.28 Calculate with numbers in standard form (2) e.g. Calculate, giving your answer in sta $\frac{1.2 \times 10^{12}}{2.4 \times 10^4}$,	When **dividing in standard form**, use the laws of indices for the powers, while dividing the numbers as usual. $\frac{1.2 \times 10^{12}}{2.4 \times 10^4} = 0.5 \times 10^8$ $= 5 \times 10^7$ Make sure numbers are in standard form.
	When **adding and subtracting in standard form**, turn the numbers given in standard form back into ordinary numbers first, add or subtract them, then convert your answer to standard form.
$(3.5 \times 10^4) + (6.2 \times 10^5)$	$(3.5 \times 10^4) + (6.2 \times 10^5)$ $= 35\ 000 + 620\ 000$ $= 655\ 000$ $= 6.55 \times 10^5$

P1: Ratio and Proportion

Use proportion to describe a part of a whole
Use a ratio and a quantity to find another quantity
Simplify a ratio
Write a ratio in the form 1:n

P1.1 Use proportion to describe a part of a whole.  Describe the proportion of the shape that is white	One white square out of 4 squares altogether. So as a fraction $\frac{1}{4}$ Part is the numerator Whole is the denominator Proportion can also be a decimal or percentage. The fraction needs to be converted. As a decimal 0.25 As a percentage 75%
P1.2 Use a ratio and a quantity to find another quantity e.g. The ratio of squash to water is 1:7. How much squash do I need for 50ml of squash	Ratio Squash : Water 1:7 X 50 on this side Multiply by the same number on this side 50:350

P1.3 Simplify a ratio e.g. simplify 12:15 Simplify 30cm:1m	e.g. 12 : 15 => 4 : 5 e.g. 30cm : 1m => 30 : 100 => 3 : 1 Divide both sides by a common factor. Convert the amounts to the same units if required,
P1.4 Write a ratio in the form 1:n e.g. Write 2:5 in the form 1:n	e.g. 2 : 5 (÷ both parts by 2) => 1 : 2.5

P1: Ratio and Proportion

Use a ratio to solve a problem, turning one ratio into another equivalent ratio

Changing an amount in proportion. The unitary method

Change an amount to compare two values

P1.5
Use ratio to solve a problem, turning one ratio into another equivalent ratio.
e.g.
A model ship is made using scale 1:600.
The model ship length is 40cm.
What is the real length of the ship?

e.g.
A model ship is made using scale 1:600.
The model ship length is 40cm.
What is the real length of the ship?

1:600

X 40 X 40

40:24000

Want to find what 40cm will be.
So multiply 1 by 40 gives 40.
Do the same to the other side of the ratio.
Convert answer into sensible units.
24000cm = 240m

P1.6
Changing an amount in proportion. The unitary method.
e.g.
If 6 books cost £22.50, how much will 11 books cost?

6 books cost £22.50

÷6 ÷6

1 book costs £3.75

x11 x11

11 books costs £41.25

It is called the unitary method because you find what 1 would be before multiplying up to find the amount you need.

P1.7
Change an amount to compare two values.
A best buy problem.
e.g
A pack of 5 pens cost £6.10
A pack of 8 pens cost £9.20
Which is the best value?

Find the cost or value of one item in each case. Divide the cost by how many.

5 cost £6.10, so 1 costs £6.10 ÷ 5
So 1 pen costs £1.22

8 cost £9.20, so 1 costs £9.20 ÷ 8
So 1 pen costs £1.15

The pack of 8 pens is the best value as the price of 1 pen is lower than in a pack of 5

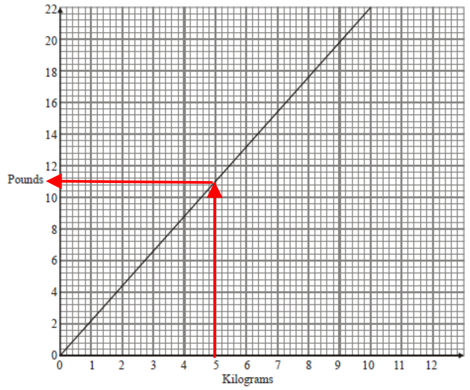
P1: Ratio and Proportion

Reading a conversion graph
Dividing into a given ratio
Use multiplier to increase by a percentage

P1.8
Reading a conversion graph

One unit will be on the x-axis, the other unit will be on the y-axis.
Find the unit value on one axis draw a line to the graph's line and another to the other axis. Read off your value.
e.g. Convert 5kg into pounds.

e.g. To convert kg and pounds



- Draw lines on to take readings
- Read the scale carefully

e.g. Convert 5kg into pounds.
From the line we can see
5kg = 11lbs

P1.9
Dividing into a given ratio
Finding different amounts given a total and different ratios

e.g. Divide £40 in the ratio 1:3:4

e.g.
Divide £40 in the ratio of 1 : 3 : 4
Total number of shares = 1+3+4 = 8
1 share = £40 ÷ 8 = £5
3 shares = 3 x £5 = £15
4 shares = 4 x £5 = £20
1:3:4 = £5:£15:£20

P1.10
Dividing into a given ratio

Using a quantity and a number of shares to find another quantity.

e.g
A and B share some sweets in ratio 3:2
A gets 12 sweets, how many sweets does B get?

e.g
A and B share some sweets in ratio 3:2
A gets 12 sweets, how many sweets does B get?
so
3 shares = 12
1 share = 12 ÷ 3 = 4
B gets 2 x 4 = 8 sweets

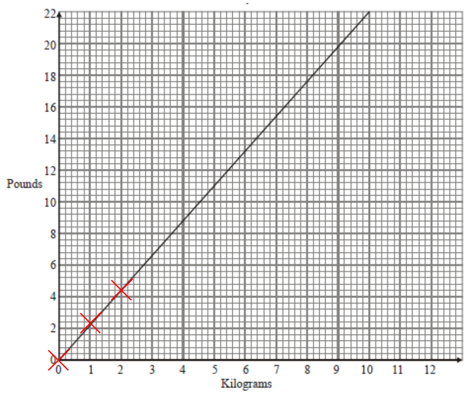
P1.11
Use multiplier to increase by a percentage.
e.g.
What is the multiplier to increase an amount by 5%?

e.g.
To increase a quantity by 5%
Amount Increased from 100% by 5%
so 100 + 5 = 105
105% as a decimal = 1.05
Multiply the quantity by 1.05

P1: Ratio and Proportion

Use multiplier to decrease by a percentage
Calculate the original amount before a percentage change (Reverse percentage)
Plotting a conversion graph

P1.12 Use multiplier to decrease by a percentage. e.g. What is the multiplier to decrease an amount by 5%?	e.g. To decrease a quantity by 5% Amount decreases from 100% by 5% so 100 - 5 = 95 95% as a decimal = 0.95 Multiply the quantity by 0.95
P1.13 Calculate the original amount before a percentage change. (Reverse Percentage) e.g. A bag costs £40 in a sale where everything has 20% off What was the original price of the bag?	e.g. A bag costs £40 in a sale where everything has 20% off What was the original price of the bag? If 20% has been taken off, then the bag is 80% of its original value. (100 - 20 = 80) So the original multiplier was 0.8 for 80% Original x 0.8 = 40 So Original = 40 ÷ 0.8 = £50

P1.14 Plotting Conversion Graphs e.g. Plot a conversion graph for Kilograms to pounds. If 1kg = 2.2lbs	e.g. Plot a conversion graph for Kilograms to pounds. If 1kg = 2.2lbs Draw suitable axes with Kilograms on one axis and Pounds on the other axis. As 1kg = 2.2lbs, plot this point on your graph. You need two more points. Double both values 2kg = 4.4lbs, plot this point Make one value zero, what happens to the other? 0kg = 0lbs, plot this point Draw a straight line through the three points with a ruler. 

P2 Proportion and Repeated Percentage Change

Understand how direct proportion affects two variables
Understand how inverse proportion affects two variables
Solve problems of direct proportion

P2.1 Understand how direct proportion affects two variables e.g. If two variables A and B are in direct proportion to one another what happens as A increase?	If A and B are in direct propotion. Then If A increases then B increases If A decreases then B decreases If A is multiplied by 2 then B is multiplied by 2. If 1 worker costs £200 to hire Then 2 workers cost £400 to hire The cost to hire is in direct proportion to how many workers are hired
P2.2 Understand how inverse proportion affects two variables e.g. If two variables A and B are in direct proportion to one another what happens as A increase?	If A and B are in inverse propotion. Then If A increases then B decreases If A decreases then B increases If A is multiplied by 2 then B is divided by 2. If 1 worker takes 2 hours to complete a job Then 2 workers will take 1 hour to complete the same job. The time taken to complete a job is inversely proportional to the amount of workers..

P2.3 Solve Problems of Direct Proportion e.g. The distance you walk is directly proportional to the time you spend walking. If I can walk 9 miles in 3 hours, how far can I walk in 5 hours?	Use Unitary Method to find how far in one hour. Divide by three then multiply by 5 9 miles : 3 hours 3 miles : 1 hour 15 miles : 5 hours Or recognise the scale factor from one value to the other. Multiply the number of hours by 3

P2 Proportion and Repeated Percentage Change

Solve problems of inverse proportion

Use similarity to find missing lengths

P2.6 Solve Problems of Inverse Proportion

The amount of time you spend on a job is inversely proportional to the amount of people doing the job.

If it takes 5 workers 6 days to build a shed. How long will it take 2 workers?

Find how long it will take for 1 worker.

5 Workers : 6 Days

÷5 ↓ ↓ x5

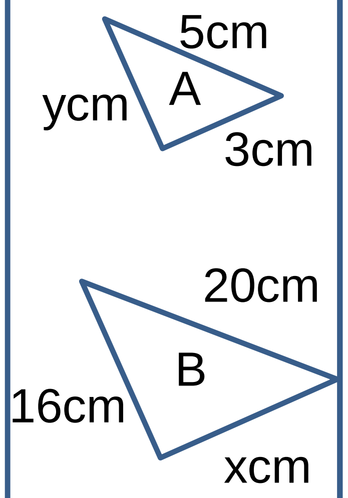
1 Worker: 30 Days

x2 ↓ ↓ ÷2

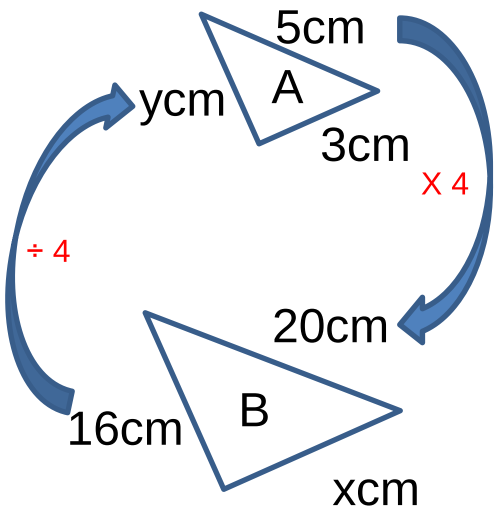
2 workers : 15 Days

Because it is inverse proportion what you do to one value, you do the inverse to the other. So when you divide the number of workers to find 1 worker, you multiply the time by 5

P2.7 Use Similarity to Find Missing Lengths



e.g. Triangle A and B are similar. What are the lengths of the missing sides?



The multiplier from one shape to the other is the same for every corresponding side

From A to B you go from 5 cm to 20cm

20 ÷ 5 = 4. So you multiply by 4

3 x 4 = 12cm, so x = 12cm

To go from B to A you do the inverse and divide by 4.

16 ÷ 4 = 4cm so y = 4cm

P2 Proportion and Repeated Percentage Change

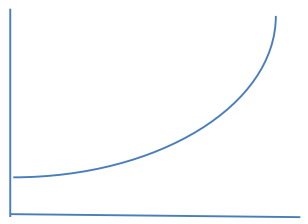
Write the formula for a repeated percentage change
Use calculations of repeated percentage change
Recognise graphs of exponential growth and decay

P2.8 Write the formula for a repeated percentage change	Find the multiplier for the percentage increse or decrease. Remember Increase by 20% then multiplier is 1.2 Decrease by 20% the multiplier is 0.8 Final amount = (multiplier)$^{\text{number of years}}$ x initial amount
P2.9 Use calculations of repeated percentage change e.g. £400 is placed in a savings account that pays 5% interest PA. How much money will be in the savings account after 5 years? Round you answer to 2d.p.	Use the formula: Final amount = (multiplier)$^{\text{number of years}}$ x initial amount PA stands for per annum which means every year. So there is a 5% increase every year. The multiplier for a 5% increase is 1.05 Using the formula Final Amount = 1.05^5 x 400 = 510.512625.... =£510.51 to 2d.p.

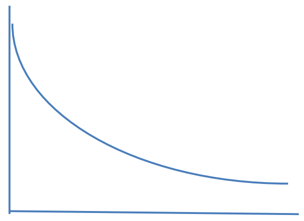
P2.10
Recognise Graphs of Exponential Growth and Exponential Decay

e.g. What would a graph of bacteria growth look like?
e.g. What would a graph of radioactive decay look like?

e.g. What would a graph of bacteria growth look like? This would be a repeated percentage increase.



e.g. What would a graph of radioactive decay look like? This would be a repeated percentage decrease



P2 Proportion and Repeated Percentage Change

To find a formula for two variables in direct proportion

To find a formula for two variables in inverse proportion

P2.11
To Find a Formula for Two Variables in Direct Proportion

e.g. y is directly proportional to x. When y = 21, x = 3.
Find a formula for y in terms of x

The symbol □ means ‘varies as’ or ‘is proportional to’.

Direct proportion

If y □ x then y = kx

If y □ x^2 then y = kx^2

If y □ x^3 then y = kx^3

e.g.
y is directly proportional to x. When y = 21, x = 3.

y □ x therefore y = kx

21 = k x

3

k = 7

so, y = 7x

P2.12
To Find a Formula for Two Variables in Inverse Proportion

e.g. a is inversely proportional to b. When a = 12, b = 4.
Find a formula for a in terms of b

The symbol □ means ‘varies as’ or ‘is proportional to’.

Inverse proportion

If y □ 1/x then y = k/x

If y □ 1/x^2 then y = k/x^2

If y □ 1/x^3 then y = k/x^3

e.g. a is inversely proportional to b.
When a = 12,
b = 4.
Find a formula for a in terms of b

a □ 1/b therefore a = k/b

12 = k/4

k = 48

so, a = 48/b

P2 Proportion and Repeated Percentage Change

Finding the multiplier or percentage change for a repeated change

Use trial and error to find the year term of a repeated change

P2.13
Finding the multiplier or percentage change for a repeated percentage change.

e.g. A savings account had £2000 in it, after three years of interest, the amount in the account was £2315.25. What was the percentage interest rate on the savings account?

Formula for repeated percentage change is
Final amount = (multiplier)$^{\text{number of years}}$ x initial amount

e.g. A savings account had £2000 in it, after three years of interest, the amount in the account was £2315.25. What was the percentage interest rate on the savings account?

Initial amount = 2000
Final amount = 2315.25
Number of years =3
Substitute into the formula

2315.25=(multiplier)^3 x 2000
Divide by 2000
1.157625 = (multiplier)^3`
Take cube root of both sides to undo the power
1.05 = multiplier
1.05 = 105%
So increase has been 5% each year.

P2.14
Use Trial and Error to find the year term of a repeated percentage change

e.g. A savings account had £2000 in it, after x years of interest of 5% PA, the amount in the account was £2315.25. How long were the savings in the account?

Formula for repeated percentage change is
Final amount = (multiplier)$^{\text{number of years}}$ x initial amount

e.g. A savings account had £2000 in it, after x years of interest of 5% PA, the amount in the account was £2315.25. How long were the savings in the account?

Initial Amount = 2000
Percentage interest per year =5%
100+5 = 105
So multiplier = 1.05

Substitute these into the formula
Keep trying the next value of x.
Final amount = 1.05^x x 2000
Try x=1, then
1.05 x 2000 = 2100 (not the final amount) so try x=2
1.05^2 x 2000 = 2205 (not the final amount) so try x=3
1.05^3 x 2000 = 2315.25 9correct amount)
So x=3 years

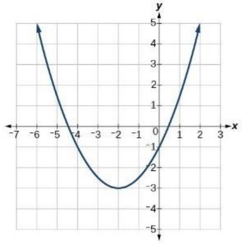
P2 Proportion and Repeated Percentage Change

Find the average or instantaneous rate of change from graph

What is the rate of change where x=0

P2.15
Find the average or instantaneous rate of change from a graph

What is the average rate of change between
x = -1 and x = 2?

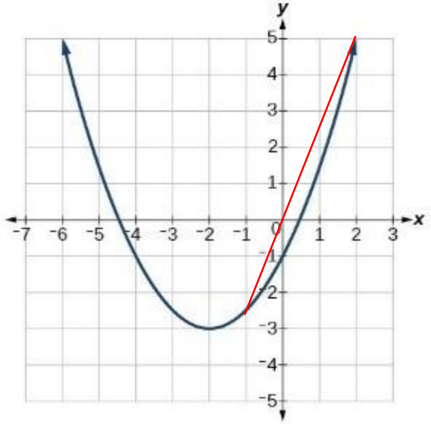


The rate of change is represented on a graph by the gradient.
The average gradient of a curve between two points is the gradient of the chord joining the two points

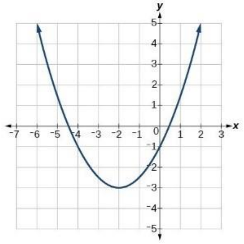
What is the average rate of change between x = -1 and x = 2?

Draw a chord on the graph between x = -1 and x = 2.
Find the gradient of the chord.
The chord passes through (-1 , -2.5) and (2 , 5)

Gradient = $\frac{5 - -2.5}{2 - -1} = \frac{7.5}{3} = 2.5$



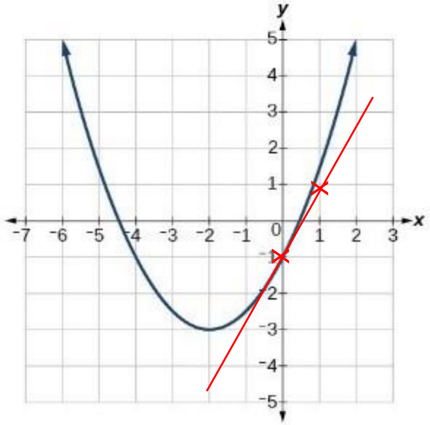
P2.16
What is the rate of change where x = 0?



The instantaneous rate of change is the gradient at a point on the curve.
Rate of change at a point on a curve = gradient of the tangent
Draw a tangent to the curve at that point and find the gradient of the tangent.
Two points on the tangent are (0 , -1) and (1 , 1)
Calculate Gradient

= $\frac{1 - -1}{1 – 0} = 2$

Rate of change at x = 0 is 2



P2 Proportion and Repeated Percentage Change

Interpret the rate of change of graph
Using similarity to find missing areas
Using similarity to find missing volumes

P2.17 Interpret the rate of change of graph e.g. What would the rate of change represent on A) A graph of number of bacteria against time. B) A graph of the number of radioactive atoms In a substance against time. C) A Distance / Time graph D) A Speed / Time graph	The rate of change of a graph is its gradient. A gradient is how much the y-axis value changes for every one value on the x-axis. e.g. What would the rate of change represent on A) A graph of number of bacteria against time. B) A graph of the number of radioactive atoms In a substance against time. C) A Distance / Time graph D) A Speed / Time graph Answers A) The rate of growth of the bacteria B) The rate of decay of the radioactive substance C) The rate of change of distance over time which is SPEED D) The rate of change of speed over time which is ACCELERATION

P2.18 Using similarity to find missing areas. If height of shape A is 4cm, height of shape B is 6cm A and B are similar shapes. If the surface area of A is $20cm^2$ what is the surface area of B?	If Length scale factor = k Then Area scale factor = $\mathbf{k^2}$ If height of shape A is 4cm, height of shape B is 6cm A and B are similar shapes. If the surface area of A is $20cm^2$ what is the surface area of B? Length scale factor = 6 ÷ 4 = 1.5 Area scale factor = 1.52 = 2.25 Surface area of B = 20 x 2.25 = $45cm^2$
P2.19 Using similarity to find missing volumes. If height of shape A is 4cm, height of shape B is 6cm A and B are similar shapes. If the surface area of A is $10cm^3$ what is the volume of B?	If Length scale factor = k Then Volume scale factor = $\mathbf{k^3}$ If the surface area of A is $10cm^3$ what is the volume of B? Length scale factor = 6 ÷ 4 = 1.5 Volume scale factor = 1.5^3 = 3.375 Volume of B = 10 x 3.375 = $33.75cm^3$

S1: Data Handling

Understand how to collect data

Understand the concept of bias when collecting data

Reading data from a table

S1.1 Understand how to collect data e.g. describe different methods of data collection.	Ways to collect data: **Data collection sheets** which are also called tally charts. (see S1.4) **Two-way tables** are a way of sorting data from more than one category, so that the frequency of each category can be seen quickly and easily. **Questionnaires** are used for most surveys. They have questions and choices of responses.
S1.2 Understand the concept of bias when collecting data e.g. explain what is meant by bias.	**Bias** occurs when one answer is favoured over another. It can lead to unreliable results. Data collection should be planned to minimise **bias**. Random samples minimise **bias**.

S1.3
Reading data from a table

e.g. using the table, answer the questions.

Country	Gold	Silver	Bronze
Spain	7	4	6
France	10	18	14
Germany	17	10	15
Italy	8	12	8
Japan	12	8	21
Australia	8	11	10

(a) How many Gold medals did Australia win?
(b) Which country won the most Silver medals?
(c) Which countries won more than 12 Bronze medals?

Read the table carefully.

Cross reference the columns and rows to find the values you are looking for.

a) Australia won 8 gold medals

b) France won the most silver medals (18)

c) France, Germany and Japan won more than 12 Bronze medals

S1: Data Handling

Collect data in a tally chart
Draw a bar chart
Interpret a bar chart
Draw a pictogram

S1.4
Collect data in a tally chart
e.g. 10 students were asked which type of movie they preferred. Their responses were horror, action, comedy, action, action, romance, comedy, action, action, horror.
Show this data in a tally chart.

On a tally chart each occurrence is shown by a tally mark.

Every fifth tally is drawn across to make a "gate".

The tallies are counted to give the frequency (f).

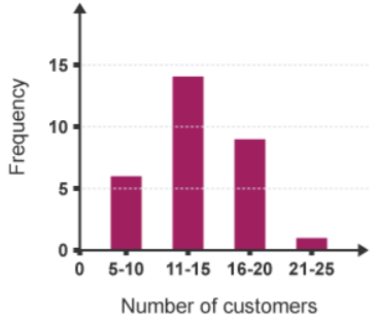
Movie Type	Tally	f
Action	~~IIII~~	5
Horror	II	2
Romance	I	1
Comedy	II	2

S1.5
Draw a bar chart

e.g. draw a bar chart from this table

Customers	f
5 - 10	6
11 – 15	14
16 - 20	9
21 - 25	1

On a **bar chart** the height of the bar is the frequency.



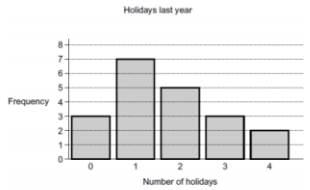
A bar chart is used for discrete data.
There must be gaps between the bars.

S1.6
Interpret a bar chart

e.g. how many people went on 1 holiday?

The x axis shows the category.
The y axis shows the frequency.

The number of people who went on 1 holiday was 7.

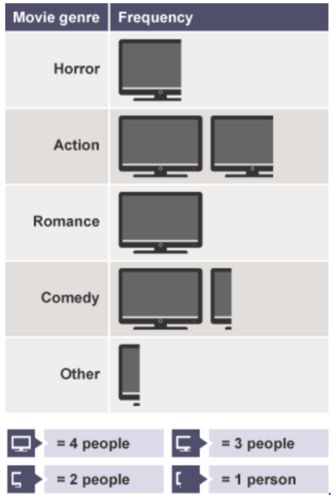


S1.7
Draw a pictogram

e.g. draw a pictogram for this table.

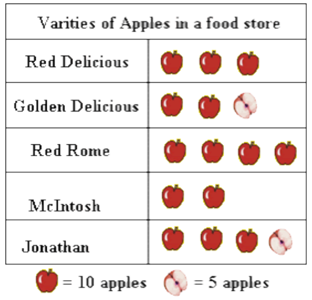
Movie Genre	f
Horror	3
Action	7
Romance	4
Comedy	5
Other	1

A **pictogram** shows frequency using pictures.
A key shows what each picture is worth.



S1: Data Handling

Interpret a pictogram
Calculate a mean from a list of numbers
Find the mode of a list of numbers
Find the median for a list of numbers

S1.8 Interpret a pictogram e.g. how many Golden Delicious were there? 	Use or interpret part of a symbol to count quantities. For Golden Delicious: 2 whole apples = 20; 1 half apple = 5; 25 apples in total.
S1.9 Calculate a mean from a list of numbers e.g. calculate the mean of 3, 4, 6, 7.	Add all the numbers. Divide by how many there are. Mean of 3, 4, 6, 7 $\frac{3+4+6+7}{4} = 5$ The mean is 5

S1.10 Find the mode of a list of numbers e.g. what is the mode of 1, 2, 3, 3, 3, 3, 5, 5? 1, 1, 2, 2, 4, 6, 7, 8, 9? 1, 2, 3, 4, 5?	The Mode is the most common number or object. 3 occurs the most so 3 is the mode. 1 and 2 occur twice, so they are the modes. The data set is bimodal.
S1.11 Find the median for a list of numbers. e.g. find the Median of 2, 7, 4, 3, 5 2, 6, 4, 7, 5, 3	All occur once so there is no mode. The Median is the middle number, or middle value of a middle pair, in an ordered list. Order the numbers - 2, 3, 4, 5, 7. 4 is in the middle, so 4 is the median. Order the numbers – 2, 3, 4, 5, 6, 7. 4 and 5 are in the middle. The middle of 4 and 5 is 4.5, so 4.5 is the median.

S1: Data Handling

Find the range of a list of numbers
Compare data distributions using averages and range
Draw a stem and leaf chart
Interpret a stem and leaf chart

S1.12
Find the range of a list of numbers

e.g. what is the range of 1, 2, 3, 4?

-4, 2 , 7 , 8?

The Range is the difference between the largest and smallest value. It is the
largest value minus the smallest value.
4 - 1 = 3, so the range is 3.
8 - -4 = 8 + 4 = 12, so 12 is the range.

S1.13
Compare data distributions using averages and range

e.g. compare the heights of boys and girls using this table.

	B	G
Mean	1.75m	1.69m
Range	32cm	25cm

To compare two or more data sets you <u>must;</u>
Compare an average for each data set,
Compare the spread of each data set.
Comments should relate to the context of the data sets.

The boys are taller, on average, than the girls since the mean is larger for the boys.

The heights of the girls are more consistent since the range for the girls is lower.

S1.14
Draw a stem and leaf chart
e.g. draw a stem and leaf chart for these data;
8, 8, 9, 11, 12, 13, 14, 14, 18, 19, 20, 23, 25, 25, 27, 27, 28, 32, 32, 33, 33, 36, 36, 38, 38, 41, 42, 43, 43, 45

Make sure data is in order.
Include a key.

0	8 8 9
1	1 2 3 4 4 8 9
2	0 3 5 5 7 7 8
3	2 2 3 3 6 6 8 8
4	1 2 3 3 5

Key: 1 | 3 = 13

This number here is 42.

S1.15
Interpret a stem and leaf chart.

e.g. find the median, range and mode from this stem and leaf.

Key: 3 | 1 means 31

Stem	Leaf
1	9 9
2	0 4 7 8
3	1 2 2 2 6
4	0 5 5
5	5

Key: 3 | 1 means 31

Stem	Leaf
1	9 9
2	0 4 7 8
3	1 2 2 2 6
4	0 5 5
5	5

Median = middle number = 32.

Mode = 32 (this occurs three times).

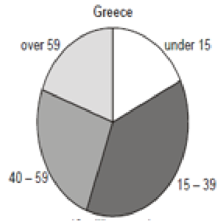
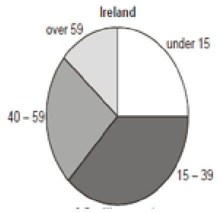
Range = 55 – 19 = 36.

S1: Data Handling

Construct a pie chart

Interpret a pie chart

Understand the different types of data

S1.16 Construct a pie chart e.g. if the frequency is 60, what is the angle that represents each person?	Divide 360 degrees by the total frequency Multiply each frequency by this number to find the angle of each sector. Number of people = 60. 360º ÷ 60 = 6º so each person = 6º.
S1.17 Interpret a pie chart e.g. which country has more people under 15?  	Pie charts show proportion. Without information on the size of the survey, actual numbers are not known. Here we are not told how many people are in each population. We can only comment on proportion by comparing the sizes of sectors in each pie chart. There is a larger proportion of the population under 15 in Ireland than there is in Greece.

S1.18 Understand the different types of data e.g. describe the following data types.	**Data** is a collective name for information recorded for statistical purposes. There are many types of data.
Qualitative	**Qualitative data** can only be written in words, e.g. the colours of cars.
Quantitative	**Quantitative data** can be written in numbers, e.g. heights of children.
Discrete	**Discrete data** is numerical data that are usually integer values, e.g. the number of children in a classroom.
Continuous	**Continuous data** is numerical data that can be shown in decimals, e.g. the weights of babies.
Primary	**Primary data** is data collected from the original source, e.g. via a survey.
Secondary	**Secondary data** is data collected from other sources, e.g. national statistics.

S1: Data Handling

Understand how to take and use a sample of data

Find the median and quartiles from a list of data

S1.19 Understand how to take and use a sample of data. e.g. describe how to take a sample.	A sample should be: a small group of the population, an adequate size, representative of the population. <u>Simple random sampling</u> Everyone has an equal chance of being part of the sample. <u>Systematic sampling</u> Arranged in some sort of order. e.g. every 10th item in the population.

S1.20 Find the median and quartiles from a list of data e.g. find the median, lower quartile, upper quartile and interquartile range from the data set; 1, 4, 7, 8, 9, 13, 16	n is the number of items in the data set (in this case 7 items). Write the values in order. M**edian** is the $\frac{(n+1)}{2}th$ value. $\frac{7+1}{2}$ = 4. 4th item is 8. **Lower Quartile (LQ)** is the $\frac{(n+1)}{4}th$ value. $\frac{7+1}{4}$ = 2. 2nd item is 4. **Upper Quartile (UQ)** is the $\frac{3(n+1)}{4}th$ value. $\frac{3(7+1)}{2}$ = 6. 6th item is 13. **Interquartile Range (IQR)** IQR = UQ – LQ = 13 – 4 = 9.

S1: Data Handling

Compare distributions by comparing mean and range in context of the distributions

Draw a two way table

Interpret a two way table

S1.21
Compare distributions by comparing the mean
and the range in context
of the distributions

e.g. compare the heights of boys and

	B	G
Median	1.65m	1.54m
IQR	33cm	27cm

To compare two or more data sets you must:
Compare an average for each data set,
Compare the spread of each data set,
Comments should relate to the context of the data sets.

The boys are taller on average than the girls since the median is higher for the boys.

The heights of the girls are more consistent since the IQR is lower.

S1.22
Draw a two-way table

e.g. draw a two way table for data about how boys and girls travel to school.

The IQR covers the middle 50%.

Two-way tables are a way of sorting
data with two variables, showing the frequency of each category quickly and easily.

To sort data by category

e.g. how students travel to school

	Bus	Walk	Cycle	Total
Boys				
Girls				
Total				

S1.23
Interpret a two way table

e.g. from the table: what is the probability a student walks?

What is the probability
of walking, given you

	Walk	Bus	Other	Total
Boys	20			55
Girls		12		
Total	36		42	100

Complete the information in the table

	Walk	Bus	Other	Total
Boys	20	**10**	**25**	55
Girls	**16**	12	**17**	**45**
Total	36	**22**	42	100

From the completed two way table:

P(Walk) = $\frac{36}{100} = \frac{9}{25}$

P(Walk given you are a girl) = $\frac{16}{45}$

S1: Data Handling

Understand how to take a stratified sample

S1.24
Understand how to take a stratified sample

e.g. given the table below, show how to take a stratified

Language	Number of students
Greek	145
Spanish	121
German	198
French	186
Total	**650**

Sample is divided into groups according to criteria. These groups are called strata.
A simple random sample is taken from each group in proportion to its size using the formula:

Number from each group =
$\frac{\text{stratum size}}{\text{population}}$ x sample size.

Number from Greek
$= \frac{145}{650} \text{ x } 70 \approx 16$

Number from Spanish
$= \frac{121}{650} \text{ x } 70 \approx 13$

Number from German
$= \frac{198}{650} \text{ x } 70 \approx 21$

Number from French
$= \frac{186}{650} \text{ x } 70 \approx 20$

This only tells us 'how many' to take.
Take a random sample from each Language.

S2: Grouped Frequency

To be able to group data into a grouped frequency table

Draw and interpret a frequency polygon

Find mean from a frequency table

S2.1

To be able to group data into a grouped frequency table

e.g. put these number of customers in a grouped frequency table.

13	8	16	12	12	16
7	18	11	16	15	7
11	12	13	21	17	19
11	14	10	19	13	12
7	16	6	14	12	18

When a lot of **data** needs to be sorted, use a **grouped frequency table**.

Consider class width carefully. The smallest number is 6 and the biggest number is 21, so groups with a width of 5 are reasonable.

Customers	Tally	Frequency
6 - 10	~~IIII~~ I	6
11 – 15	~~IIII~~ ~~IIII~~ IIII	14
16 – 20	~~IIII~~ IIII	9
21 - 25	I	1

S2.2

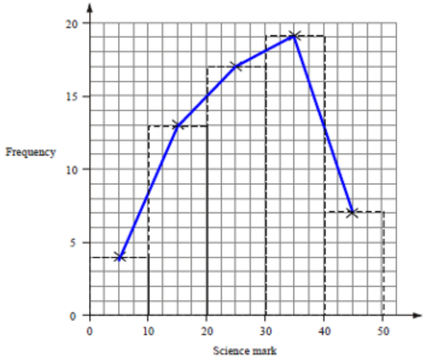
Draw and interpret a frequency polygon.

e.g. draw a frequency polygon for the following information.

Science Mark	Frequency
0 - 10	4
10 – 20	13
20 – 30	16
30 – 40	19
40 – 50	7

A **frequency polygon** shows the frequencies for different groups.

To plot a frequency polygon of grouped data, plot the frequency at the midpoint of each group.



S2.3

Find mean from a frequency table

e.g. find the mean from this table.

Goals (x)	Frequency (f)
0	2
1	2
2	5
3	1
	10

The **mean** is found by adding up all the numbers and dividing by how many numbers there are.

The total amount of goals can be worked by multiplying goals (x) by the frequency (f), to give fx.

Goals (x)	Frequency (f)	fx
0	2	0 x 2 = 0
1	2	1 x 2 = 2
2	5	2 x 5 = 10
3	1	3 x 1 = 3
	10	15

The total number of goals is 15.
There were 10 football games.
15 ÷ 10 = 1.5, so the mean is 1.5.

S2: Grouped Frequency

Find median from a frequency table
Find range from a frequency table
Find the mode from a frequency table
Construct a scatter graph

S2.11
Find median from a frequency table

e.g. find the median from this table.

Goals (x)	Frequency (f)
0	2
1	2
2	5
3	1
	10

The **median value** is the middle value
when all items are in order.

Median = $\frac{n+1}{2}$ th value.

n (total frequency) is 10.

Median = $\frac{10+1}{2} = \frac{11}{2}$ = 5.5^{th} value.

The median is halfway between the 5th and 6th items of data.

Goals (x)	Frequency (f)	Cumulative
0	2	2
1	2	2 + 2 = 4
2	5	4 + 5 = 9
3	1	9 + 1 = 10

The 5th item of data is 2.
The 6th item of data is 2.
The median number of goals is 2.

2.4
Find range from a frequency table

e.g. find the range from this table.

Goals (x)	Frequency (f)
0	2
1	2
2	5
3	1
	10

The **range** is the highest value take away the lowest value.

The highest value in the table is 3 goals.
The lowest value is 0 goals.
The range is 3 – 0 = 3 goals.

2.5
Find the mode from a frequency table

e.g. find the mode from this table.

Goals (x)	Frequency (f)
0	2
1	2
2	5
3	1
	10

The **modal value** is the value with the
highest **frequency**.

There were five football matches where 2 goals were scored, which is a higher frequency than any other amount of goals.

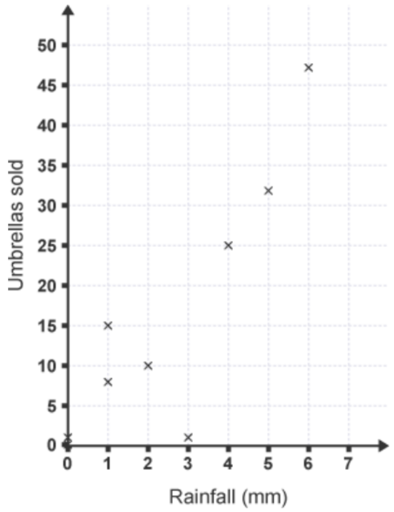
The modal amount of goals scored is 2.

2.6
Construct a scatter graph

e.g. construct a scatter graph from this data.

Rainfall (mm)	Umbrellas Sold
3	1
2	10
4	25
0	0
0	1
5	32
6	47
1	8
1	15

Scatter graphs are used to see if there is a **correlation** between two sets of data.



S2: Grouped Frequency

Identify the correlation of a scatter graph

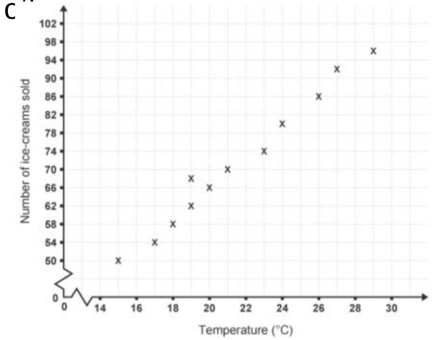
Describe the relationship presented by a scatter graph

2.7
Identify the correlation of a scatter graph

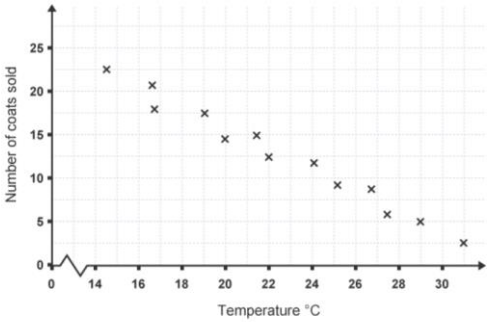
e.g. sketch a scatter graph showing positive correlation and a scatter graph showing negative correlation.

Graphs can either have positive correlation, negative correlation or no correlation.

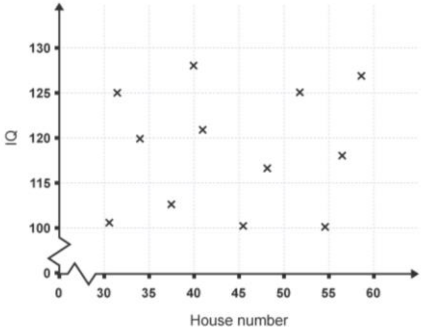
Positive correlation means as one variable increases, so does the



Negative correlation means as one variable increases, the other decreases.

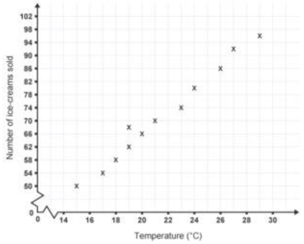


No correlation means there is no connection between the two va



2.8
Describe the relationship presented by a scatter graph

e.g. describe the relationship shown in this scatter graph.



The relationship presented by a scatter graph is described by its correlation.

It is important that you mention both variables in your description of the relationship.

There is a positive correlation between sales of ice cream and the temperature, so temperatures rises so does the sale of ice cream.

S2: Grouped Frequency

Find Draw a line of best fit for a scatter graph

Use a scatter graph to estimate results

Estimate the mean from a grouped frequency table

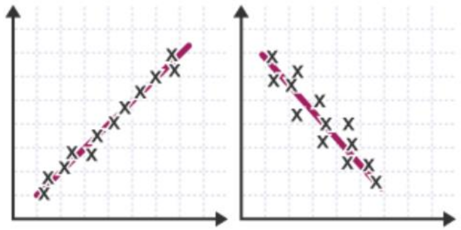
2.9

Draw a line of best fit for a scatter graph.

e.g. draw a line of best fit for positive and negative correlation.

A **line of best fit** is a sensible straight line that goes as centrally as possible through the coordinates plotted.

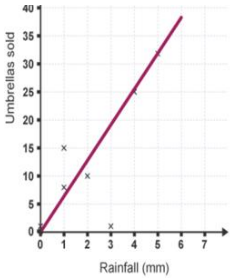
There should roughly be the same



2.10

Use a scatter graph to estimate results

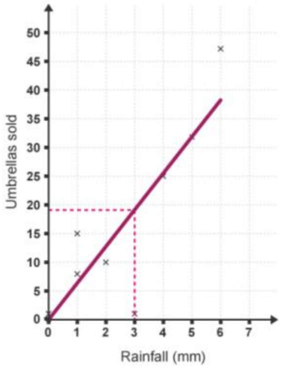
e.g. estimate how many umbrellas will be sold given 3mm of rainfall?



Estimate results using the line of best fit.

Find 3 mm of rainfall on the graph.

Draw a line going up from 3 mm, then draw a line across to the y axis.



2.12

Estimate the mean from a grouped frequency table.

e.g. estimate the mean from this table.

Minutes Late (m)	Frequency
0 < m ≤ 4	11
4 < m ≤ 8	13
8 < m ≤ 12	7
12 < m ≤ 16	9
16 < m ≤ 20	4

We don't know the exact value of each item of data in each group.

The best estimate we can make is to use the midpoint of each group.

Minutes Late (m)	Frequency	Midpoint
0 < m ≤ 4	11	2
4 < m ≤ 8	13	6
8 < m ≤ 12	7	10
12 < m ≤ 16	9	14
16 < m ≤ 20	4	18

The total number of minutes late can be found by multiplying the frequencies by the midpoints.

Minutes Late (m)	Frequency	Midpoint	mp x f
0 < m ≤ 4	11	2	22
4 < m ≤ 8	13	6	78
8 < m ≤ 12	7	10	70
12 < m ≤ 16	9	14	126
16 < m ≤ 20	4	18	72
	44		368

The estimate of the mean is calculated by dividing the total minutes late by the total number of trains (total frequency).

Mean $\approx \frac{368}{44} \approx$ 8.4 minutes.

S2: Grouped Frequency

Identify the modal class of a grouped frequency table

Identify the class containing the median from a grouped frequency table

Understand the terms extrapolation and interpolation related to scatter graphs

Calculate cumulative frequency

2.13
Identify the modal class of a grouped frequency table.

e.g. find the modal class from this frequency table.

Minutes Late (m)	Frequency
0 < m ≤ 4	11
4 < m ≤ 8	13
8 < m ≤ 12	7
12 < m ≤ 16	9
16 < m ≤ 20	4

The modal class is the group with the highest frequency.

The group with the highest frequency is 4 < m ≤ 8 which occurs 13 times.

The modal class is 4 < m ≤ 8.

2.14
Identify the class containing the median from a grouped frequency table

e.g. find the class containing the median from this table.

Minutes Late (m)	Frequency
0 < m ≤ 4	11
4 < m ≤ 8	13
8 < m ≤ 12	7
12 < m ≤ 16	9
16 < m ≤ 20	4

The **median value** is the middle value when all items are in order.

Median = $\frac{n+1}{2}$ the value.

n (total frequency) is 44.

Median = $\frac{44+1}{2} = \frac{45}{2}$ = 22.5^{th} value.

The median is halfway between the 23rd and 24th items of data.

Using cumulative frequency, the 24^{th} item is at the end of the 4 < m ≤ 8 class, so the 23^{rd} item is also in that class.

The median value is in the 4 < m ≤ 8 class.

2.15
Understand the terms extrapolation and interpolation related to scatter graphs

Interpolation is predicting within the range of the data.
This is seen as a reliable estimation.

Extrapolation is predicting from outside of the range of the data.
It is subject to greater uncertainty.

2.16
Calculate cumulative frequency

e.g. use this table to calculate cumulative frequency.

Length (cm)	Frequency
30 < l ≤ 35	4
35 < l ≤ 40	10
40 < l ≤ 45	11
45 < l ≤ 50	12
50 < l ≤ 55	3

To calculate the cumulative frequencies, add the frequencies together.

Length (cm)	Frequency	Cum Freq
30 < l ≤ 35	4	4
35 < l ≤ 40	10	14
40 < l ≤ 45	11	25
45 < l ≤ 50	12	37
50 < l ≤ 55	3	40

S2: Grouped Frequency

Plot a cumulative frequency chart

Read median and quartiles from cumulative frequency chart

2.17
Plot a cumulative frequency chart

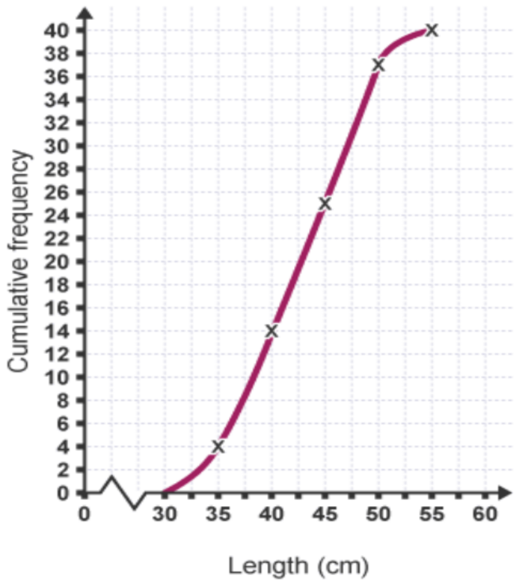
e.g. plot a cumulative frequency chart or graph from this table.

Length (cm)	f	Cum Freq
30 < l ≤ 35	4	4
35 < l ≤ 40	10	14
40 < l ≤ 45	11	25
45 < l ≤ 50	12	37
50 < l ≤ 55	3	40

A cumulative frequency diagram is drawn by plotting the upper class boundary with the cumulative frequency.

Cumulative frequency is plotted on the vertical axis and length is plotted on the horizontal axis.

Points are joined with a smooth curve.



2.18
Read median and quartiles from cumulative frequency chart

e.g. find the median, lower quartile and upper quartile from the cumulative frequency graph in section 2.17.

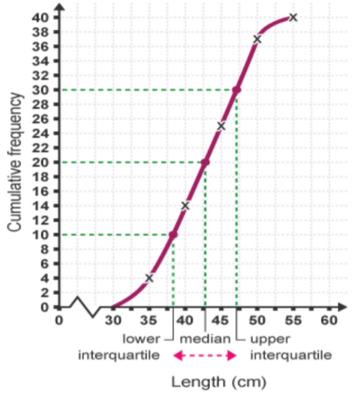
To find values, draw a line across from the position and read down from the curve.
s the number of items in the data set (40).

Median is the $\frac{n}{2}th$ value.
$\frac{40}{2}$ = 20. 20th item is approximately 43.

Lower Quartile (LQ) is the $\frac{n}{4}th$ value.
$\frac{40}{4}$ = 10. 10th item is approximately 38.

Upper Quartile (UQ) is the $\frac{3n}{4}th$ value.
$\frac{3(40)}{4}$ = 30. 30th item is approximately 47.

Interquartile Range (IQR)
IQR = UQ – LQ = 47 – 38 = 9.



S2: Grouped Frequency

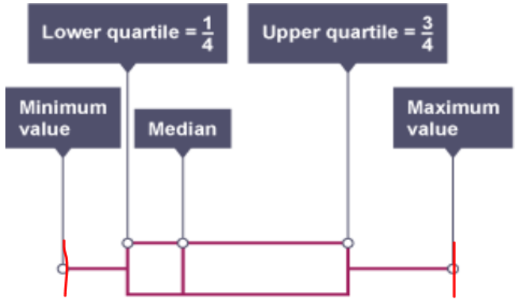
Draw a box plot

Draw a box plot from a list of numbers

2.19
Draw a box plot

e.g. show the values required to draw a box plot.

A **box plot** is a visual representation of the **median** and **quartiles** of a set of **data**.
To draw a box plot, the following values are needed:
minimum;
lower quartile;
median;
upper quartile;



2.19
a) Draw a box plot from a list of numbers.

e.g. draw a box plot from this list of numbers:
9, 10, 10, 12, 13, 14, 17, 18, 19, 21, 21.

Box plots can be created from a list of
numbers by finding the median, lower and upper quartiles.

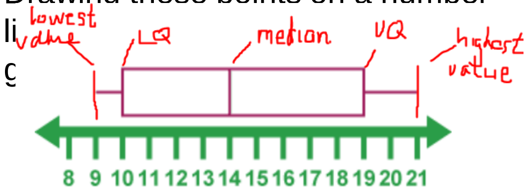
Minimum value = 9.
Maximum value = 21.

Median is the $\frac{n+1}{2}th$ value.
$\frac{11+1}{2}$ = 6. 6^{th} item is 14.

Lower Quartile (LQ) is the $\frac{n+1}{4}th$ value.
$\frac{11+1}{4}$ = 3. 3^{rd} item is 10.

Upper Quartile (UQ) is the $\frac{3(n+1)}{4}th$ value.
$\frac{3(11+1)}{4}$ = 9. 9^{th} item is 19.

Drawing these points on a number li



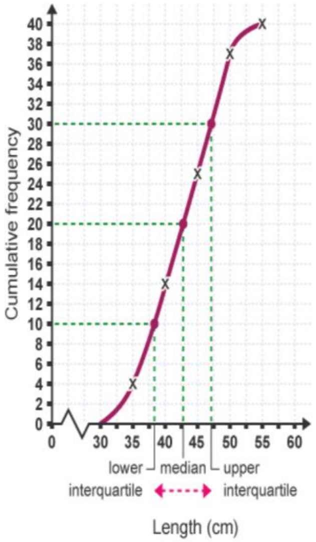
S2: Grouped Frequency

Drawing a box plot from a cumulative frequency graph

Compare distributions displayed as box plots by comparing the median and the interquartile range in context

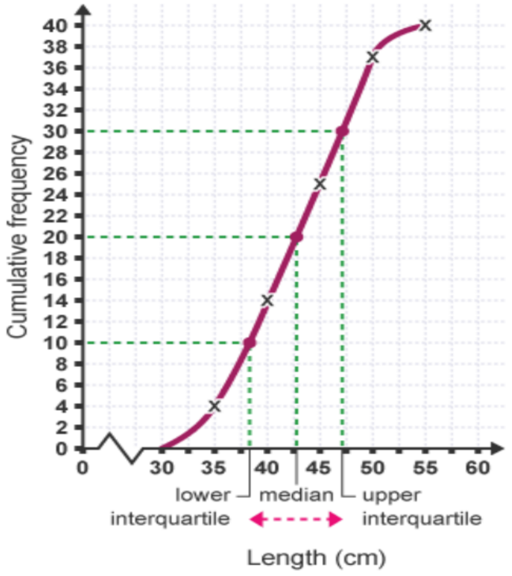
2.19
b) Drawing a box plot from a cumulative frequency graph

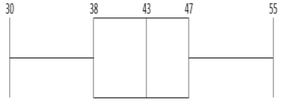
e.g. draw a box plot for the cumulative frequency chart.



Find the maximum, minimum, median and quartiles from the **cumulative frequency** graph.

The minimum and maximum values of the box plot are where the cumulative frequency begins and ends



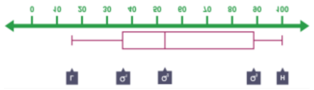


2.20
Compare distribution displayed as box plots by comparing the median and the interquartile range (IQR) in context

e.g. give two comparisons for these two boxplots.

Mr Wilson's Maths class.

Mr Galbraith's English class.



Compare the median for both box plots.

The median for Mr Wilson's results (62) is higher than median for Mr Galbraith's results (53).
On average, Mr Wilson's class performed better in the test in Maths than Mr Galbraith's class did in English.

Compare the IQR for both box plots.

The pupils in Mr Galbraith's class had more varied results as their IQR (53) is greater than the IQR (28) in Mr Wilson's class.

S2: Grouped Frequency

Know how to calculate frequency density for a histogram of unequal widths

Calculate frequencies from a histogram of unequal widths

2.21
Know how to calculate frequency density for a histogram of unequal widths

e.g. calculate the frequency density from these values.

Age (a)	Frequency
5 ≤ a < 11	6
11 ≤ a < 16	15
16 ≤ a < 17	4

On a **histogram** the area of the bar shows the frequency of the **data**.

Histograms are typically used when the data is in groups of unequal width.

Frequency density is used instead of frequency.

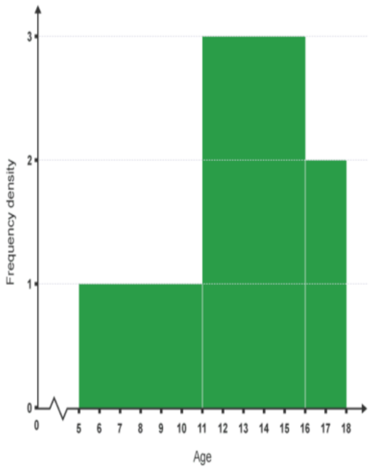
Frequency density (FD) = $\frac{frequency}{class\ width}$

Age (a)	Frequency	Class Width	FD
5 ≤ a < 11	6	6	1
11 ≤ a < 16	15	5	3
16 ≤ a < 17	4	2	2

2.22
Plot a histogram of unequal widths.

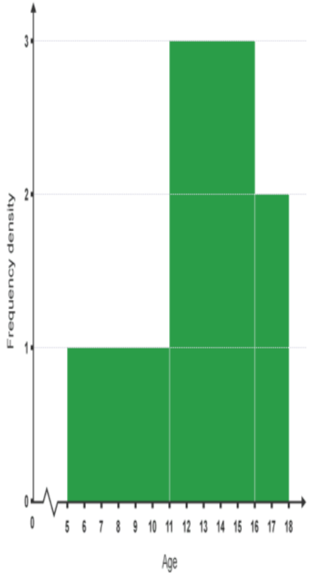
e.g. plot a histogram from this table in section 2.21.

Plot Frequency Density on the y axis.



2.23
Calculate frequencies from a histogram of unequal widths

e.g. calculate the frequency for each category from the histogram.



Frequency = Frequency Density x Class Width

Children aged 5 – 11:
Frequency = 1 x 6 = 6.

Children aged 11 – 16:
Frequency = 3 x 5 = 15.

Children aged 16 – 18:
Frequency = 2 x 2 = 4.

S3: Probability

Calculate the theoretical probability of an event
Use the exhaustive rule of probability,
Use a sample space to find the probability of a combined event
Use the property that the sum of mutually exclusive probabilities is 1

S3.1
Calculate the theoretical probability of an event

e.g. What is the theoretical probability of rolling a 6 on a single die?

- **Calculate probability**

$$P(\text{event}) = \frac{\text{No. of outcomes which give the event}}{\text{Total number of outcomes}}$$

Probability of rolling a 6
There is only one 6 on the die
There are 6 numbers on the die

$P(6) = \frac{1}{6}$

S3.2
Use the exhaustive rule of probability, the probability of an event + the probability of that event not happening = 1

e.g. The probability it will rain today is 0.7. What is the probability it won't rain today?

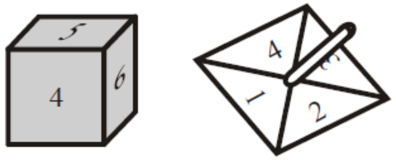
Probability of an event NOT happening

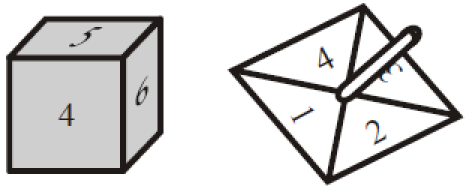
If P (event) = p
P (event NOT happening) = 1 – p

e.g. P (rain) = 0.7
P (not rain) = 1 – 0.7 = 0.3

S3.3
Use a sample space to find the probability of a combined event

e.g. A dice is rolled and a spinner is spun and the scores are added together. Create a sample space diagram to show all possible outcomes from spinning a spinner and rolling a dice.





		Dice					
	+	1	2	3	4	5	6
Spinner	1	2	3	4	5	6	7
	2	3	4	5	6	7	8
	3	4	5	6	7	8	9
	4	5	6	7	8	9	10

S3.4
Use the property that the sum of mutually exclusive probabilities is 1

e.g. If outcomes A and B are mutually exclusive and the probability of A occurring is 0.47 … what is the probability of B occurring?

If 2 outcomes cannot occur together they are mutually exclusive
If 2 outcomes A and B are mutually exclusive
P(A) + p(B) = 1

1 - P(A) = P(B)
1 - 0.47 = P(B)
P(B) = 0.53

S3: Probability

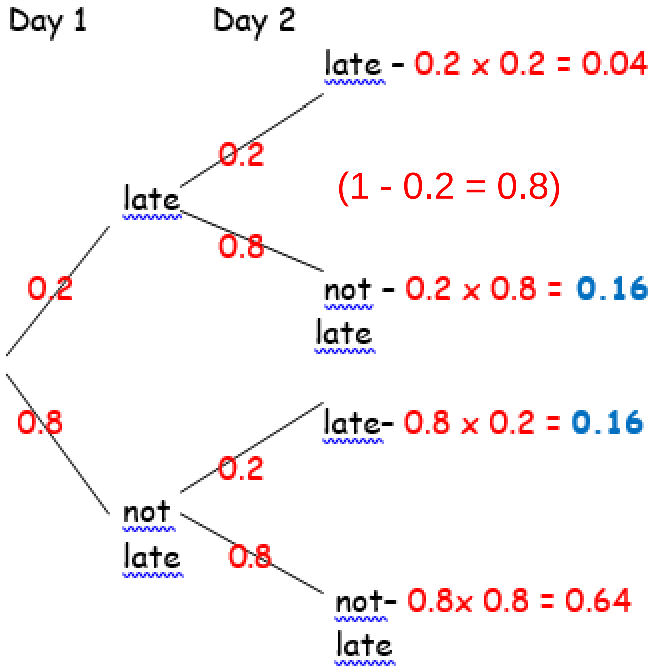
Calculate relative frequency

Understand the limitations and use of elative frequency

Draw a tree diagram for independent events

S3.5 Calculate relative frequency e.g. St Benedict's Football Club has won 7 matches out of the 10 this season. What is the probability they will win their next match?	Relative frequency = $\frac{\text{Number of times outcome occurs}}{\text{Total number of trials}}$ $= \frac{7}{10}$ = 0.7
S3.6 Understand the limitations and use of relative frequency e.g. Lily scored 4 out of the 10 shots during netball training. Lily says "The probability of me scoring is 40%". Is Lily correct? How could Lily improve the accuracy of her estimate?	Yes Lily is correct. $\frac{4}{10}$ = 40% Increase the amount of trials. The more times that an experiment has been carried out, the more reliable the relative frequency is as an estimate of the probability.

S3.7 Draw a tree diagram for independent events e.g. The probability Jane is late for school is 0.2. What is the probability she is only late one day on Monday and Tuesday next week?	The probability that Jane is late = 0.2



To find the probability of late on only one day:

day1 late & day2 not late	OR	day1 not late & day 2 late
= 0.16	+	0.16

= 0.32

S3: Probability

Draw a tree diagram for dependent events
Add two probabilities using the OR rule
Multiply two probabilities using the AND rule

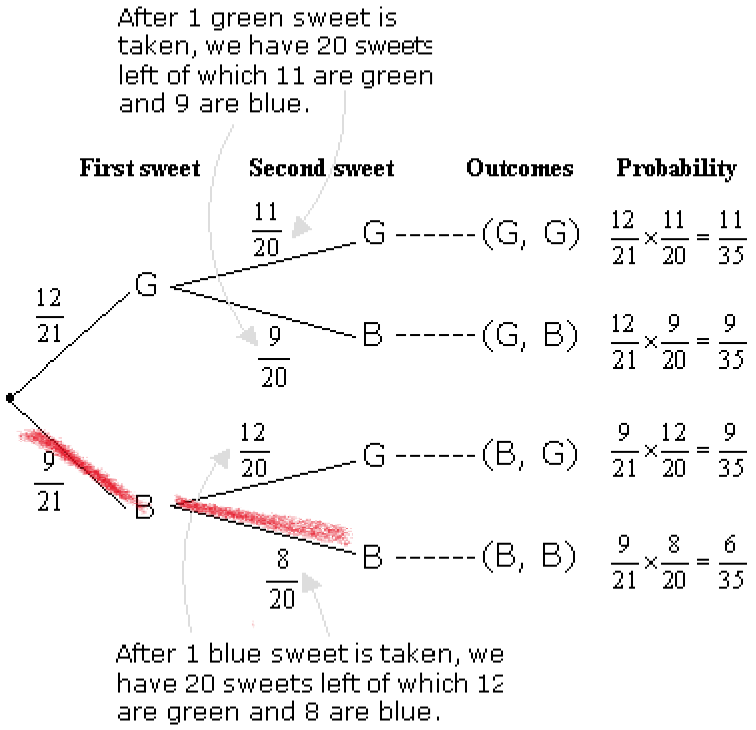
S3.8
Draw a tree diagram for dependent events

And

S3.11
Calculate probabilities from a tree diagram

e.g. A jar consists of 21 sweets. 12 are green and 9 are blue. William picked one sweet and then picked another without replacing the first.

Draw a tree diagram to represent the experiment and find the probability that both sweets are blue.



P(both sweets are blue) = P(B, B)

$$=\frac{9}{21}\times\frac{8}{20}=\frac{6}{35}$$

S3.9
Add two probabilities using the OR rule.

e.g. The probability of picking a spade from a deck of cards is $\frac{1}{4}$. The probability of picking a club from a deck of cards is $\frac{1}{4}$. What is the probability of picking a spade or a club?

P(A or B) = P(A) + P(B)

Use this addition rule to find the probability of either of two mutually exclusive events occurring.

P(S or C) = P(S) + P(C)

P(S or C) = $\frac{1}{4}+\frac{1}{4}$

$=\frac{2}{4}=\frac{1}{2}$

S3.10
Multiply two probabilities using the AND rule.

e.g. A fair die is rolled. What is the probability that the number is even and less than 4?

P(A and B) = P(A) x P(B)

Use this multiplication rule to find the probability of both of two independent events occurring.

P(E and <4) = P(E) x P(<4)

$=\frac{1}{3}\times\frac{1}{2}$

$=\frac{1}{6}$

S3: Probability

Draw a Venn diagram from given information or probabilities

Use set notation

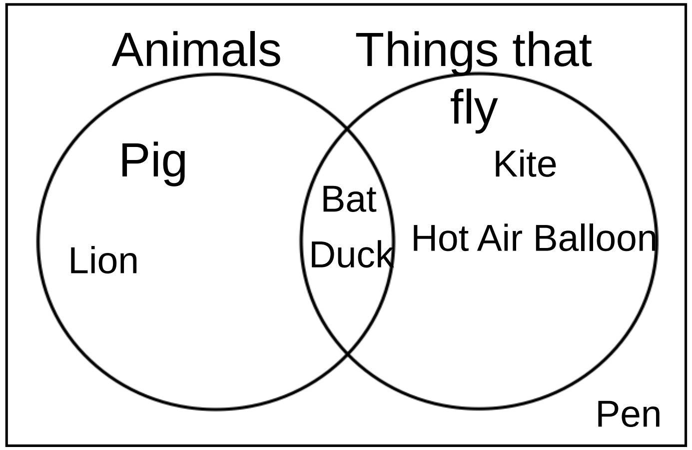
S3.12

Draw a Venn diagram from given information or probabilities.

e.g. Draw a Venn diagram to show categories of “Things that fly” and “Animals” for the following;

- Pig
- Hot Air Balloon
- Pen
- Bat
- Lion
- Kite
- Duck

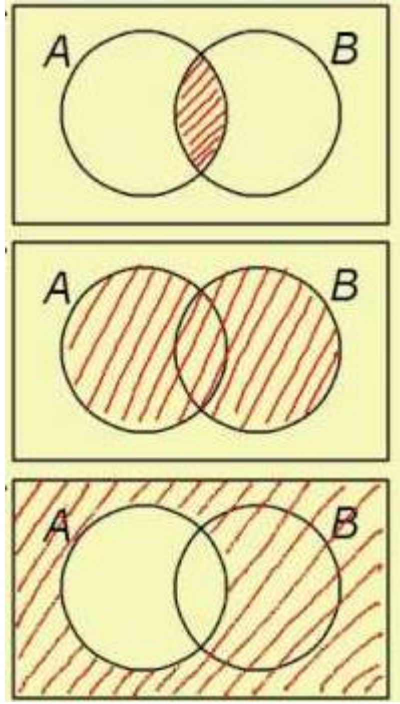
1. Draw a rectangle
2. Draw two or three circles according to how many categories you have. There are two categories in the sample question: Make sure the circles overlap.
3. Write your items in the relevant circle. If items fit both categories, write those where the circles overlap (the “intersection”).
4. If you have something which doesn’t fit a category (pen) write it within the rectangle but outside the circles.



S3.13

Use set notation

e.g. Write the three areas shaded set notation.



∪: Union of two sets.

Things that are in either set A <u>or</u> set B

∩: Intersection of two sets.

Things that are in set A <u>and</u> also in set B.

A′: Complement of a set.

The elements <u>not</u> in Set A.

1. $A \cap B$
2. $A \cup B$
3. A'

S3: Probability

Use intersection, union and complement with sets and Venn diagrams

Find probabilities using a Venn diagram

S3.14

Use intersection, union and complement with sets and Venn diagrams.

e.g. Mr Peake asks 24 pupils in his class about their families.

He sorts them into:

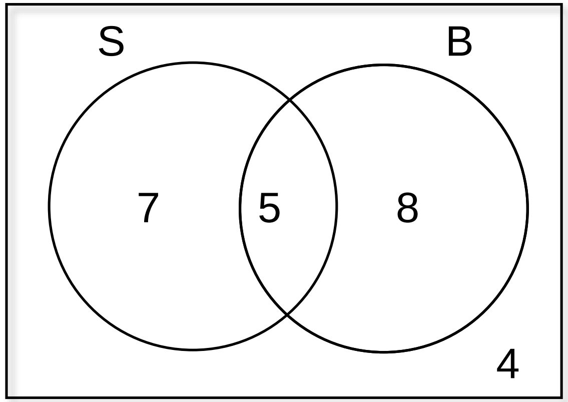
S - Has sisters

B - Has brothers

He then displays his findings in a Venn diagram.

Using this Venn diagram, work out:

1. $S \cap B$
2. $S' \cap B$



(See previous page for Set Notation)

1. Means S AND B so people who have sisters and brothers - the intersection.

= **5**

2. S' means NOT S.

$\cap B$ Means AND B

There are 12 people who do not have sisters but only 8 of those don't have a brother.

= **8**

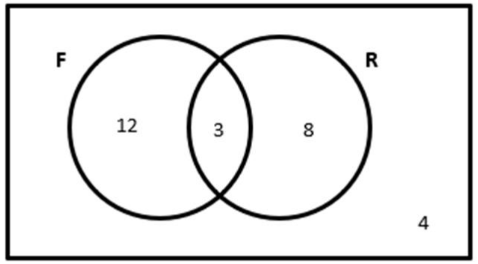
S3.15

Find probabilities using Venn diagrams

e.g. The Venn Diagram below shows if students play Football or Rugby.

A pupil is chosen at random.
What is the probability:

a) They play football
b) They play football and rugby
c) The don't play either

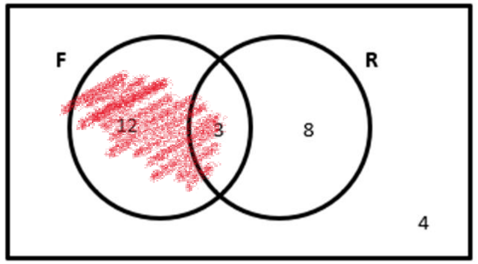


Total number of students = 12 + 3 + 8 + 4 = 27

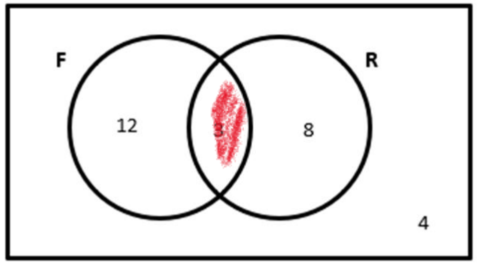
This is the denominator!

a) 12 + 3 = 15

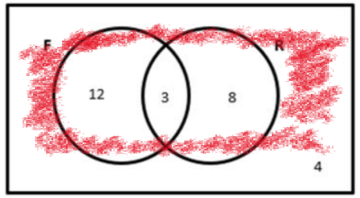
$\frac{\mathbf{15}}{\mathbf{27}}$



b) $\frac{\mathbf{3}}{\mathbf{27}}$



c) $\frac{\mathbf{4}}{\mathbf{27}}$



S3: Probability

Calculate conditional probability

Use formula to prove two events are independent

S3.16

Calculate conditional probability.

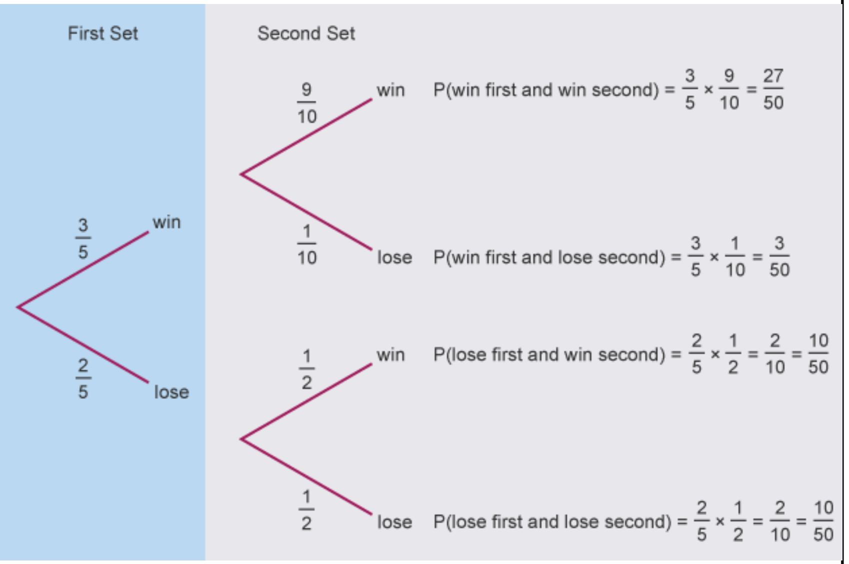
e.g. The probability that a tennis player wins the first set of a match is $\frac{3}{5}$.

If she wins the first set, the probability that she wins the second set is $\frac{9}{10}$.

If she loses the first set, the probability that she wins the second set is $\frac{1}{2}$.

Given that the tennis player wins the second set, find the probability that she won the first set.

First, represent the information on a tree diagram:



From the tree diagram, the probability of winning the second set = $\frac{27}{50} + \frac{10}{50} = \frac{37}{50}$.

This means that in every 50 matches, she may win the second set 37 times (37 becomes the denominator of the conditional probability). Out of those 37 times, on 27 occasions she won the first set and on 10 occasions she lost the first set.

Therefore, given that she wins the second set, the probability she won the first set is $\frac{27}{50}$.

There is also a formula that can be used for conditional probability:

$$P(A \text{ given } B) = \frac{P(A \text{ and } B)}{P(B)} = \frac{\frac{27}{50}}{\frac{37}{50}} = \frac{27}{37}$$

S3.17

Use formula to prove two events are independent

e.g.

You toss a coin and roll a dice. Are these events independent?

An independent event is an event that has **no connection** to another event's chances of happening.

Events A and B are independent if:

P (A ∩ B) = P(A) x P(B).

P (5 on the dice) = $\frac{1}{6}$

P (Heads) = $\frac{1}{2}$

P (5 and Head) = $\frac{1}{12}$ (a sample space would show this)

Since $\frac{1}{6}$ x $\frac{1}{2}$ = $\frac{1}{12}$ they are independent.

S3: Probability

Find combinations and permutations

S3.18 Find combinations and permutations. e.g. A pizza restaurant offers a choice of toppings: ham (H), pepperoni (P), mushroom (M) and chicken (C). How many ways can two different toppings be chosen?	When you make a selection of items from a group and the order doesn't matter, it is a **Combination**. Like ingredients in a smoothie - they’re all getting blended together! List the combinations: HP, HM, HC, PM, PC, MC. There are 6 combinations.
e.g. A man owns three cars: 1 red, 1 blue and 1 white. How many ways can they be parked on his drive?	When you select all the items in a group and the order **does** matter it is a **Permutation**. Like the code to a safe - it only works if you put the numbers in in the right order. List the permutations: RBW, RWB, BWR, BRW, WRB, WBR. There are 6 permutations.